July 13, 1959

Aviation Week

Including Space Technology

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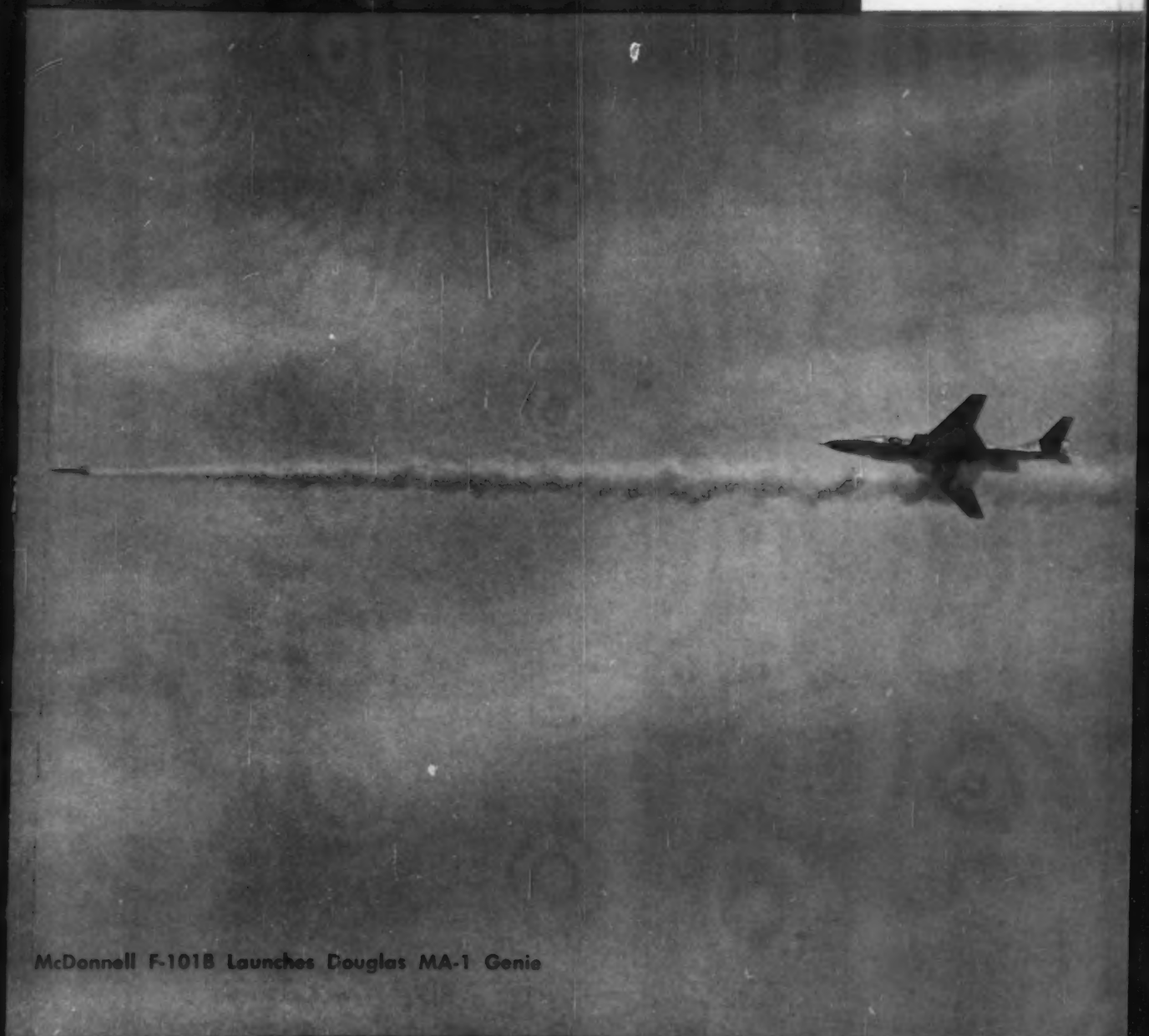
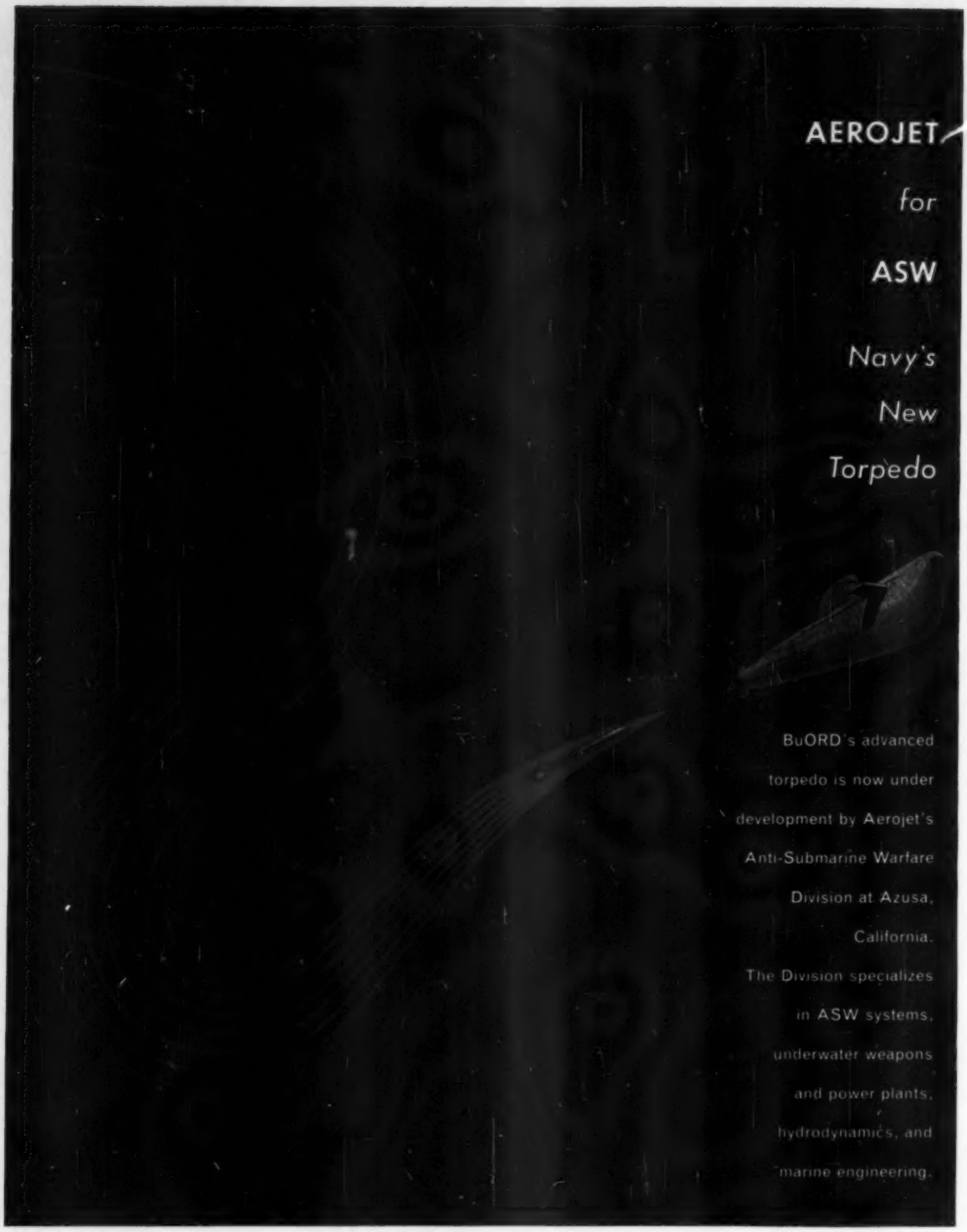
ARPA Studies Auxiliary Space Power



McDonnell F-101B Launches Douglas MA-1 Genie

Pilot Report on Comet 4 Jet Transport



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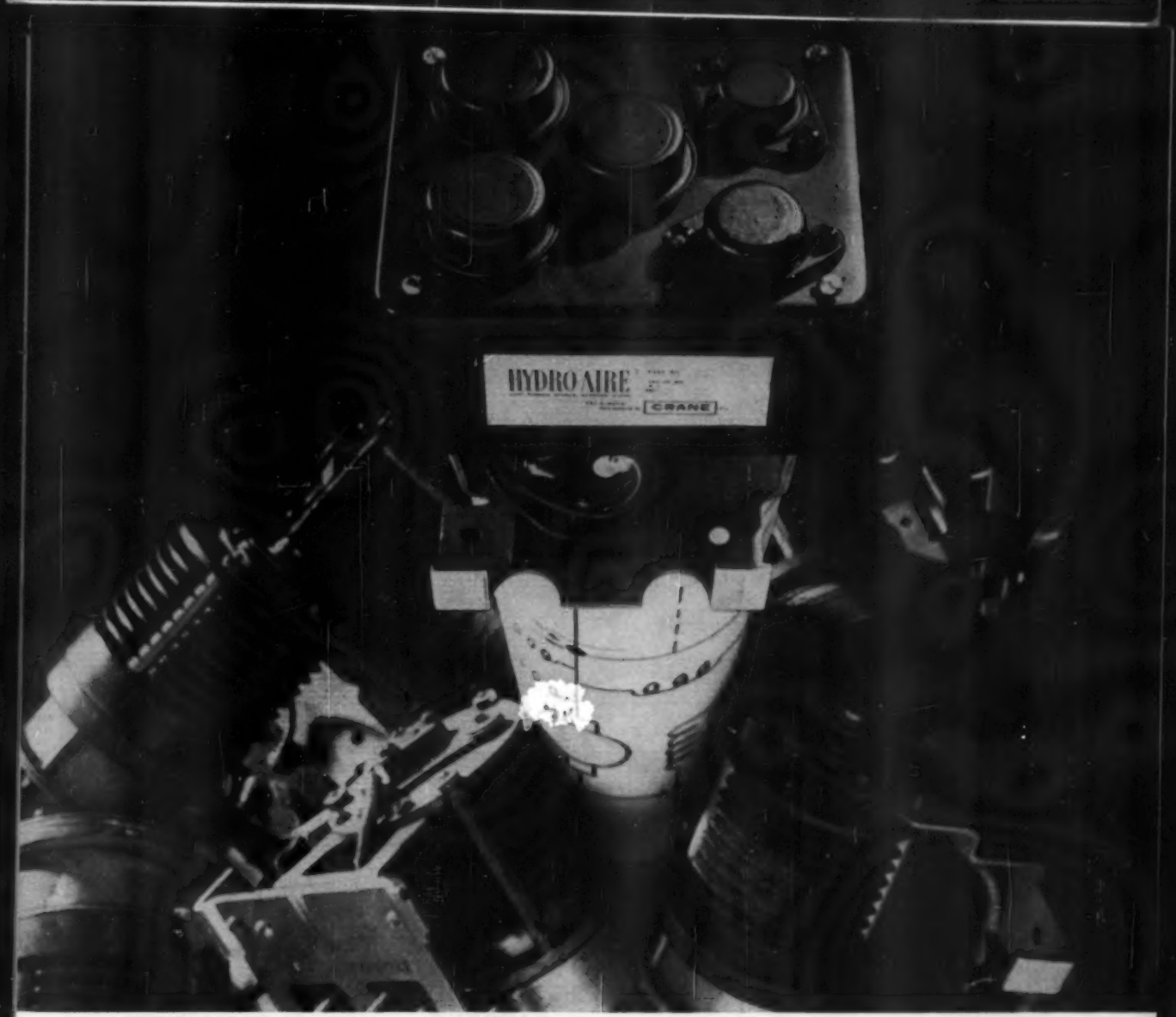

When d-c generator regulation troubles pile up...

Specify Hydro-Aire's new transistorized voltage regulator

Hydro-Aire's new, completely transistorized regulator for d-c generators weighs less than half as much as the conventional carbon-pile regulator that it replaces. Response time is five times better, and operational life is extended to 10,000 hours. The new Hydro-Aire units are physically and functionally interchangeable with MIL-standard carbon-pile regulators – plug directly into existing receptacles.

Other important features of the new Hydro-Aire unit: Has no moving parts, requires no shock mounting, dissipates virtually no heat, requires no forced cooling, adjusts easily to different voltages.

Model 50-029 (shown above) has these characteristics:

Voltage: may be set to any value between 26 and 30 volts, in increments of 0.1 volt.
Temperature limits: —55°C to +71°C
Rated life: 5000 hours without maintenance
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Weight: 1¼ pounds

Additional ratings are available and our laboratories welcome the opportunity to design new devices to your specific requirements.

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AVIATION CALENDAR

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"GOOD WILL" is the disposition of the pleased customer to return to the place where he has been well treated.
– U.S. Supreme Court

AVIATION CALENDAR

July 20-21—Propellant Thermodynamics and Handling Conference, American Rocket Society's Propellants and Combustion Committee, Ohio Union, Ohio State University campus, Columbus, Ohio.

July 30-31—Sixth Annual Symposium on Computers and Data Processing, Denver Research Institute, Stanley Hotel, Estes Park, Colo.

Aug. 4-5—Second Annual Western Regional Meeting, American Astronautical Society, Ambassador Hotel, Los Angeles, Calif.

Aug. 5-7—William Frederick Durand Centennial Conference on the problems of hypersonic and space flight, Stanford University, Stanford, Calif.

Aug. 9-12—Third National Heat Transfer Conference & Exhibit, University of Connecticut, Storrs, Conn. Sponsors: American Society of Mechanical Engineers; American Institute of Chemical Engineers.

Aug. 11-13—Wright Air Development Center Symposium on Aircraft Structural Fatigue Problems, Dayton Biltmore Hotel, Dayton, Ohio. (Confidential clearance required; must be filed with the Symposium Arrangements Committee, WCO, WADC, Wright-Patterson AFB, Ohio.)

Aug. 12-14—Eighth Annual Conference on Applications of X-Ray Analysis, Stanley Hotel, Estes Park, Colo. Sponsor: Metallurgy Division, Denver Research Institute.

Aug. 17—First National Ultrasonics Symposium, Institute of Radio Engineers' Professional Group on Ultrasonics Engineering, Stanford University, Stanford, Calif.

Aug. 18-21—Western Electronic Show & Convention, Institute of Radio Engineers, Cow Palace, San Francisco, Calif.

Aug. 23—Downtown Baton Rouge Exchange Club's Sky-O-Rama, Baton Rouge, La. Program includes the Blue Angels and military displays, both flying and static.

Aug. 24-26—Gas Dynamics Symposium,

(Continued on page 6)

AVIATION WEEK Including Space Technology

July 13, 1959
Vol. 71, No. 2

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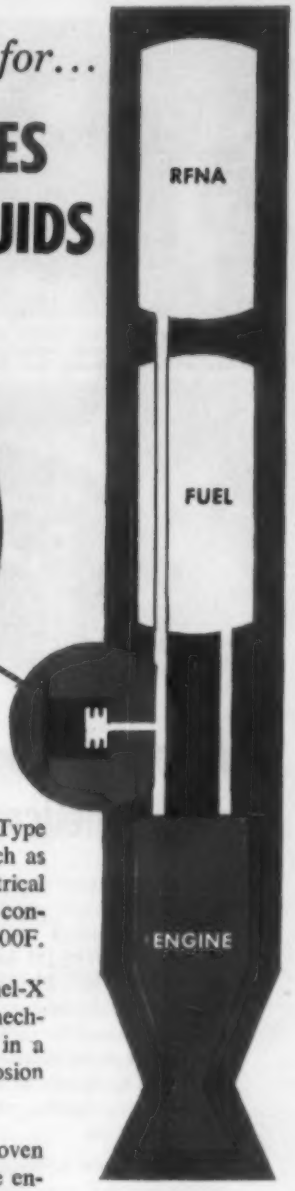
HIGH TEMPERATURES and CORROSIVE FLUIDS

Type P103
Pressure Potentiometer
shown ¾ size



New Trans-Sonics* Pressure Potentiometers, Type P103, measure pressures of corrosive fluids such as red fuming nitric acid (RFNA) and unsymmetrical dymethylhydrazine (UDMH) for telemetry and control applications at ambient temperatures up to 600F.

Corrosive fluids are contained by a welded Inconel-X bellows which actuates a dynamically balanced mechanism. This mechanism is hermetically sealed in a stainless steel case for protection against corrosion and other environmental hazards.

Accurate and reliable performance has been proven under the following conditions typical of missile environments: *Random Gaussian Vibration* 0.1g²/cps, 15 to 2,000 cps; *Acceleration* 75g; *Shock* 75g.

Flexibility of installation is assured by small size and light weight. Dimensions are 1⅞" diameter by 1⅜" long. Weight is only 6 ounces. Standard ranges are 0-100 and 0-150 psia . . . other ranges to special order. Write for Technical Bulletin P103 to Trans-Sonics, Inc., Dept. 7, Burlington, Mass.

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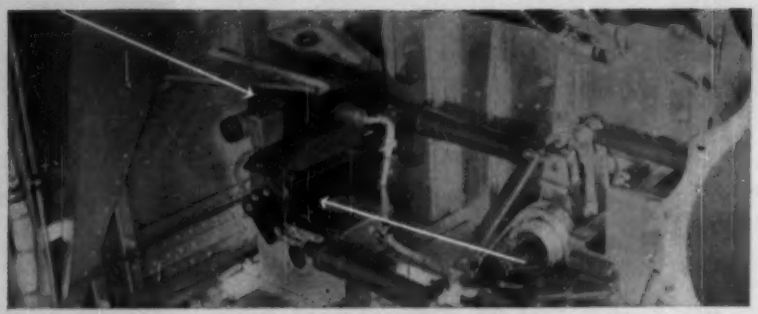
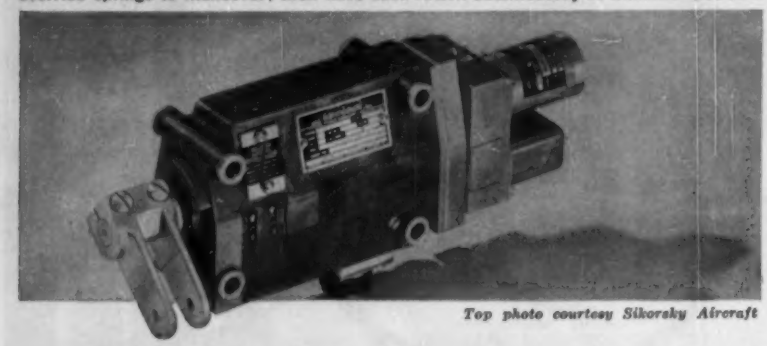


Trim system of Sikorsky HUS-1 and HSS-1N helicopters utilizes two special Airborne rotary actuators, acting through force gradient springs, to position and hold cyclic sticks. Pilot can override springs to maneuver; then have stick return automatically to trimmed position.



Top photo courtesy Sikorsky Aircraft

Airborne special actuators provide helicopter trim control

One of the more recent applications of Airborne special design actuators is found on Sikorsky's HUS-1 and HSS-1N helicopters. Two Airborne R4610 TRIM TROL units are used on these aircraft as moveable anchor points for a force gradient system of trim control. The system is an ingenious one, offering the pilot several control options.

For example, to make a quick maneuver, he can override the force gradient springs manually, without disengaging the actuator clutches. When released, the stick then returns automatically to original position. Alternatively, he can disengage the clutches by pushing the stick trim button, thus removing the force gradient system from the controls while maneuvering to a new flight condition. In this instance, the stick remains spring centered in the new position when the button is released.

A third control option permits changing flight attitude by power. Using a "beeper" button, the pilot energizes the actuators to drive the stick slowly to a new trim position, where it remains centered when the button is released. Finally, the system can be disconnected entirely, leaving the stick free and without artificial feel.

A detailed description of this system and the actuators employed is contained in new Airborne Bulletin PS-3A, available on request.

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AVIATION CALENDAR

(*Continued from page 5*)

American Rocket Society, Northwestern University, Evanston, Ill.

Aug. 24-26—Institute of the Aeronautical Sciences' National Specialists Meeting, a symposium on anti-submarine warfare, (classified), San Diego, Calif.

Aug. 27-28—International Commonwealth Spaceflight Symposium, Church House, Westminster, London, England.

Aug. 31-Sept. 2—Annual Army-Navy Instrumentation Program (ANIP) Symposium and Industry Briefing, Statler Hilton Hotel, Dallas, Tex.

Aug. 31-Sept. 5—10th Annual Congress, International Astronautical Federation, Church House, Westminster, London.

Sept. 1-2—Conference on physical chemistry in aerodynamic and space flight, University of Pennsylvania, Philadelphia, Pa. Sponsors: Air Force Office of Scientific Research and General Electric Co.'s Missile and Space Vehicle Dept.

Sept. 2-4—1959 Cryogenic Engineering Conference, University of California, Berkeley, Calif.

Sept. 3-6—National Convention and Aerospace Panorama, Air Force Assn., Exhibition Hall, Miami Beach, Fla.

Sept. 7-13—1959 Farnborough Flying Display and Exhibition, Society of British Aircraft Constructors, Farnborough, England.

Sept. 9-11—Sixth Midwestern Conference on Fluid and Solid Mechanics, University of Texas, Austin, Tex. Sponsors: AFOSR/Directorate of Aeronautical Sciences; Office of Naval Research; National Science Foundation.

Sept. 14-15—Titanium Metallurgy Conference, New York University's College of Engineering. For information: Dr. Harold Margolin, New York University, University Heights 53, New York City.

Sept. 16-17—Western Regional Meeting on Frontiers on Science and Engineering, Institute of the Aeronautical Sciences, Los Angeles, Calif.

Sept. 20-25—14th Annual Conference and Exhibit, Instrument Society of America, Chicago Amphitheater, Chicago, Ill.

Sept. 21-22—Eighth Annual Meeting, Standards Engineering Society, on Investment in Survival, Somerset Hotel, Boston, Mass.

Sept. 21-25—14th Annual Conference & Exhibit, Instrument Society of America, Chicago, Ill.

Sept. 23-24—Engine and Operations Symposium, Airwork Corp., Millville, N. J.

Sept. 28-30—1959 National Symposium on Telemetering, Civic Auditorium and Whitcomb Hotel, San Francisco, Calif. Sponsor: Institute of Radio Engineers' Professional Group on Space Electronics & Telemetry.

Sept. 30-Oct. 2—13th Annual Meeting, Southeastern Airport Managers' Assn., Washington Duke Hotel, Durham, N. C.

Oct. 5-7—Seventh Anglo-American Aeronautical Conference, Institute of the Aeronautical Sciences, Hotel Astor, New York.

Oct. 5-10—National Aeronautic Meeting, Society of Automotive Engineers, the Ambassador, Los Angeles, Calif.

Oct. 12-16—15th General Convention of the International Air Transport Assn., Tokyo, Japan.

AUTOMATIC TRANSLATION

Computing machines aid language research at Ramo-Wooldridge

To formulate rules for automatic language translation is an enormously subtle and complex project. Yet significant progress is being made. During the past year of research at Ramo-Wooldridge over 60,000 words of Russian text have been translated and analyzed using an electronic computer. From the beginning several hundred syntactic and semantic rules have been used to remove ambiguities that are otherwise present in "word for word" translation. Our present computer program for automatic translation is a considerable improvement over earlier attempts.

Apart from the question of translation itself, electronic computers are invaluable for language research. The expansion of existing knowledge of the rules of language, through statistical analysis, is made practical by mechanized procedures. A clear symbiosis between linguistics and computer technology has emerged.

Automatic translation research is one of many R-W activities addressed to problems of communication of scientific information. These problems are increasing at an accelerating pace. In this area, as in others, scientists and engineers find at Ramo-Wooldridge challenging career opportunities in fields important to the advance of human knowledge. *The areas of activity listed below are those in which R-W is now engaged and in which openings also exist:*

- Missile electronics systems
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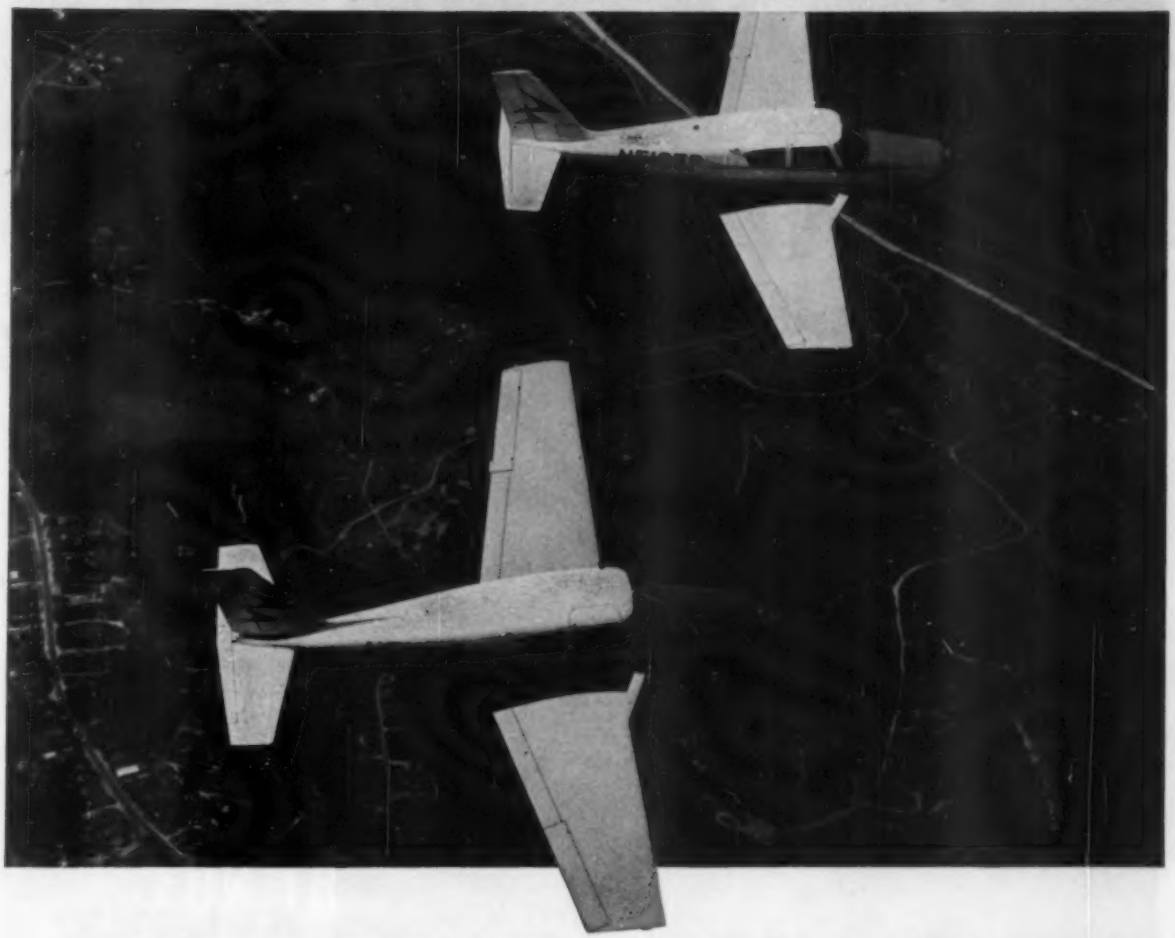

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PIPER SPECIFIES HARRISON OIL COOLERS FOR NEW FOUR-PASSENGER BUSINESS AIRCRAFT

Engine heat gets the "Indian sign" from Harrison in these Piper Comanches! Piping hot in popularity, they cruise cool with lightweight, durable Harrison heat exchangers. Both Comanches shown, the four-cylinder 180 and the six-cylinder 250, are ideal for the modern business executive . . . for the man on the move! Naturally, Piper must demand absolute dependability. That's why Harrison is specified for engine oil cooling on these two featured stars of the Piper business fleet. Piper and manufacturers of every type of modern aircraft, from transcontinental bombers to city-hopping helicopters, rely on Harrison for the finest in cooling equipment. Harrison offers engineering excellence, production skill and never-ending research backed by nearly a half century of experience in the heat-control field. If *you* have a cooling problem, look to Harrison for the answer!

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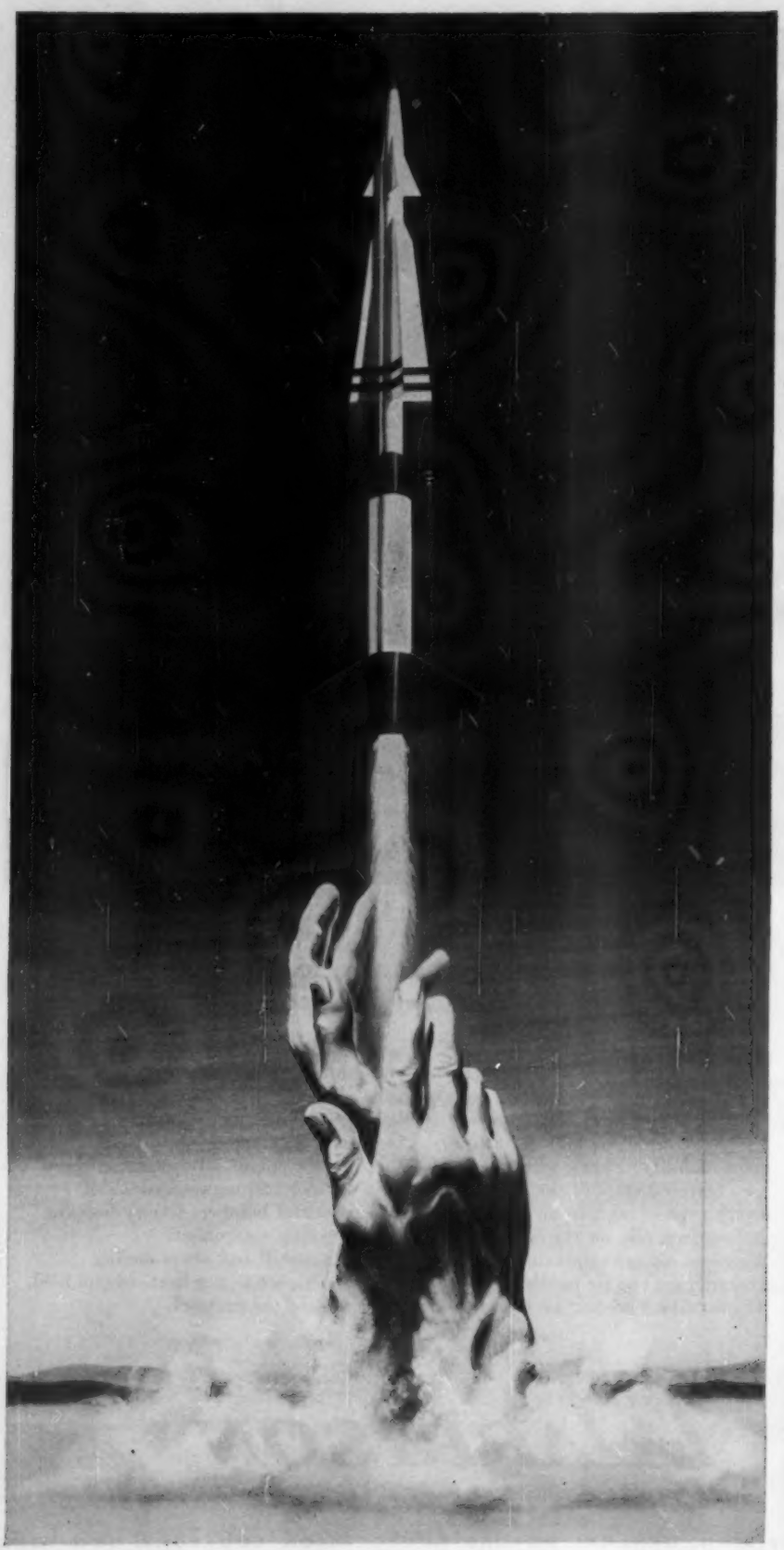

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RESULT—gleaming pods that enclose ready-to-go jet power for Douglas' superb DC-8 Jetliner and supporting pylons also built by Ryan. These jet pods are an important contribution to the success of this greatest new airliner—created in the finest Douglas transport tradition.

Ryan is well-equipped to meet the challenges of precision production of DC-8 pods and pylons. For more than 33 years Ryan and Douglas have been doing business together. We are proud of this long association and the confidence which Douglas has placed in Ryan products and the excellence of their performance—for Ryan does Build Better.

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EXPANDING THE FRONTIERS OF SPACE TECHNOLOGY... IN TEST

Testing is a vital part of every stage in the development of missile and space programs at Lockheed Missiles and Space Division.

The Division maintains one of the most completely equipped test laboratories in the world. Equipment includes: altitude, temperature and humidity chambers; shaker and vibration systems; G-accelerators; and apparatus capable of performing chemical, metallurgical, plastic, heat transfer, hydraulic, pneumatic shock, acceleration, sinusoidal and random vibration, structural, electrical and electronic tests. Static field testing; research and development testing on controls; testing in ordnance and hydraulics and high-pressure gas and propulsion systems are conducted at the 4,000 acre, company-owned test base in the Ben Lomond mountains near Santa Cruz, Calif.

Unique Flight Test Concept – Flight testing is conducted at Cape Canaveral, Florida; Alamogordo, New Mexico; and Vandenberg AFB near Santa Maria, California, in a unique manner. All components and sub-systems of a new project are initially tested on known-performance, production missiles. Thus, when the final system is ready for first flight, its individual components already possess flight-tested reliability. This new concept of flight testing is a major contribution and has enabled Lockheed to produce extremely complex missile systems in record time and at greatly reduced expense.

Underwater launch tests, for the Navy POLARIS FBM, are carried on at the Sunnyvale facility and at the Navy test base on San Clemente Island. These include studies of cavitation, wave simulation and skip motion. In addition, structural and other tests are performed at Hunter's Point Naval Shipyard, California.

Engineers and Scientists – Lockheed Missiles and Space Division has complete capability in more than 40 areas of science and technology. Its programs reach far into the future and deal with unknown and challenging environments. If you are experienced in one of the above areas, or in related work, we invite you to share in the progress of a company that has a continual record of achievement and to make an important individual contribution to your nation's competence in space technology.

Write: Research and Development Staff, Dept. G1-17, 962 W. El Camino Real, Sunnyvale, California. U.S. citizenship required.

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In our inquiries we rely not only on our own resources but also on the talents of General Motors Corporation, its Divisions, and other organizations and individuals. By applying this systems engineering concept to new research projects we increase the effectiveness with which we accomplish our mission—exploring the needs of advanced propulsion and weapons systems.

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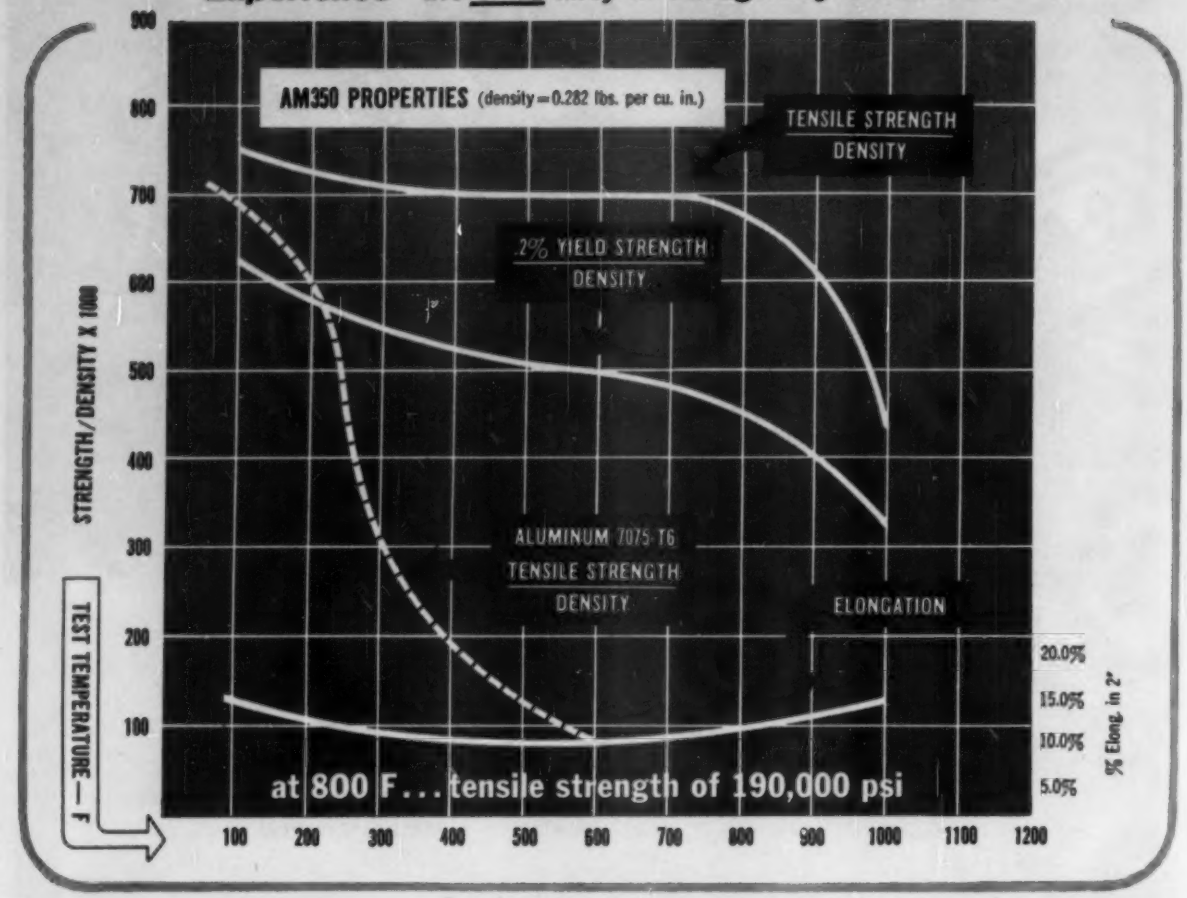
Experience—*the extra alloy in* **Allegheny Stainless**



Here are the facts on AM350 and AM355, Allegheny Ludlum's precipitation hardening stainless steels

A unique combination of highly desirable properties is the usual description of Allegheny Stainless AM350 and AM355 Steels. They combine high strength at both room and elevated temperatures, excellent corrosion resistance, ease of fabrication, low temperature heat treatment, good resistance to stress corrosion.

They are proving the answer to many problems of the air age. Airframe and other structural parts, pressure tanks, power plant components, high pressure ducting, etc. are all natural missile and supersonic aircraft applications for AM350 and AM355.

Availability: AM350, introduced several years ago, is available commercially in sheet, strip, foil, small bars and wire. AM355, best suited for heavier sections, is available in forgings, forging billets, plate, bar and wire.

Corrosion resistant: Being stainless steels, these alloys resist corrosion and oxidation. Compared to the older, more familiar stainless grades, their corrosion rating is better than the hardenable grades (chromium martensitic) but generally less than the old corrosion resistant standbys, the 18 and 8's. Stress corrosion is resisted at much higher hardness levels than with martensitic stainless.

Simple heat treatment: High strength is developed by two methods, both involving less than ordinary temperatures and minimizing oxidation and distortion problems. The most popular, and one that develops slightly better properties, is the Allegheny Ludlum developed sub-zero cooling and tempering (SCT condition). The material is held at minus 100 F for 3 hrs plus 3 hrs at 850 F. Alternate method is Double Aged (DA): 2 hrs at 1375 F plus 2 hrs at 850 F.

Easy fabrication: AM350 and AM355 can be spun, drawn, formed, machined and welded using similar procedures as with the 18-8 stainless types. In the hardened condition (SCT & DA) some forming may be done . . . 180 degree bend over a 3T radius pin. Also it can be dimpled in the hard condition to insure accurate fit-up.

For further information, see your A-L sales engineer or write for the booklet "Engineering Properties, AM350 and AM355." *Allegheny Ludlum Steel Corporation, Oliver Building, Pittsburgh 22, Pa.* Address Dept. AW-19.

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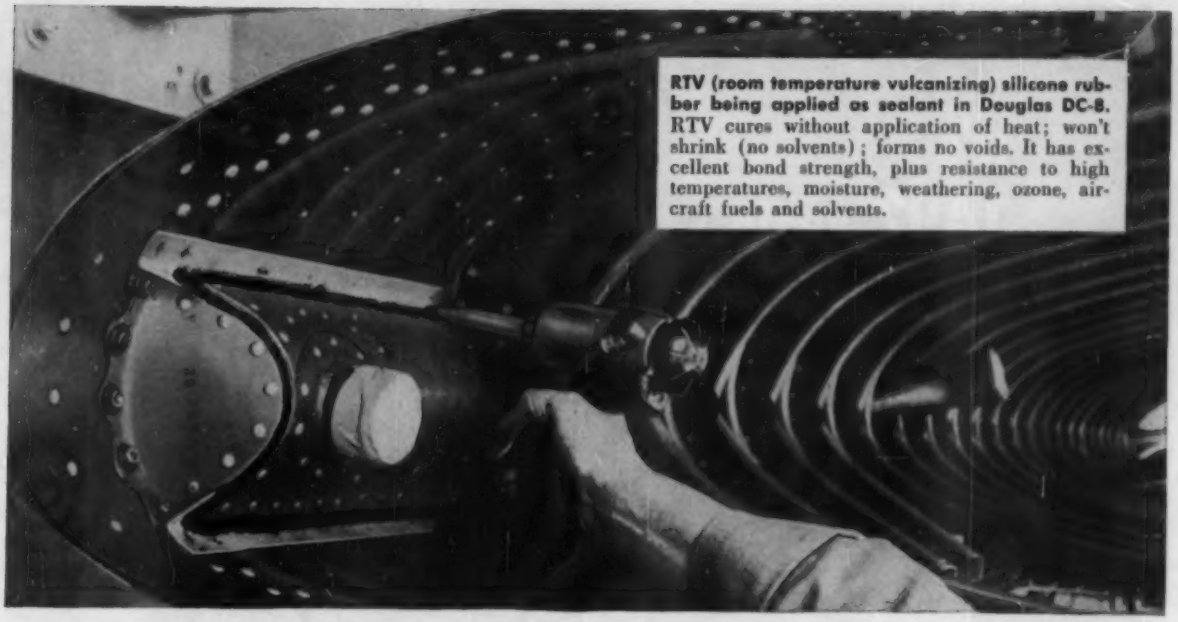
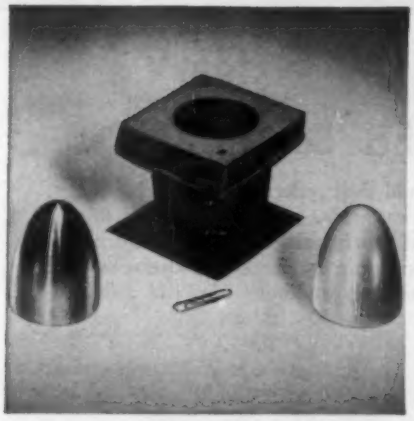


RTV (room temperature vulcanizing) silicone rubber being applied as sealant in Douglas DC-8. RTV cures without application of heat; won't shrink (no solvents); forms no voids. It has excellent bond strength, plus resistance to high temperatures, moisture, weathering, ozone, aircraft fuels and solvents.

G-E RTV silicone rubber—a superior material for tooling, encapsulating and sealing



Prototype jet engine nose cone (right) cast in RTV mold. Epoxy parts cast in flexible RTV molds have a bright, glossy surface and reproduce extremely fine detail. No parting agent is required for even the most complex parts. High tensile and tear strength is retained even after prolonged heat aging.

Close-tolerance, non-standard helix gear cast complete in low-cost, one-piece RTV mold. Previously such replacement parts had to be machined by hand. Now they can be quickly and inexpensively replaced by using the broken part as a master.

Potting and encapsulating of electrical components, such as this aircraft transformer, are easy with RTV. It can be poured, sprayed, painted or applied by dipping. Temperature resistant from −60°F to +600°F; excellent resistance to high altitude arc-over and corona. Comes in wide viscosity range.

For application data and samples of General Electric RTV silicone rubber, write to General Electric Company, Silicone Products Department, Section J72, Waterford, N. Y.

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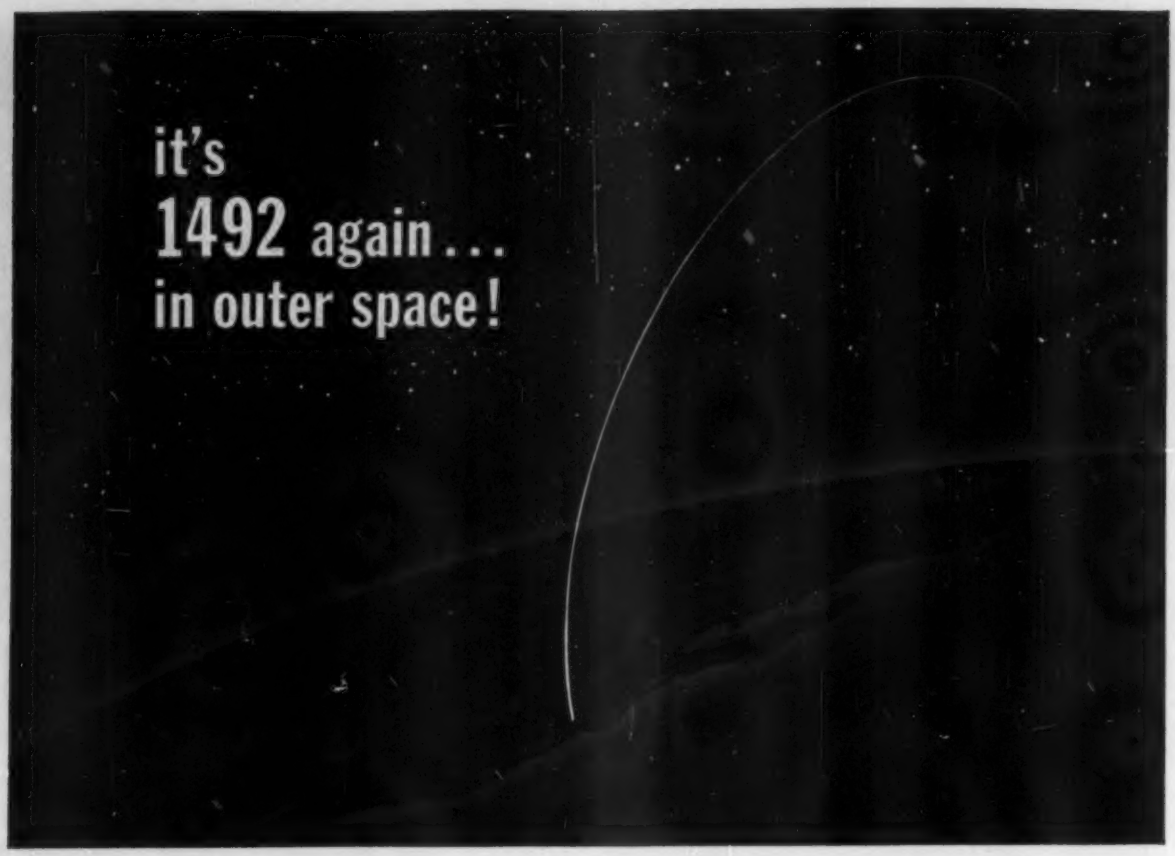

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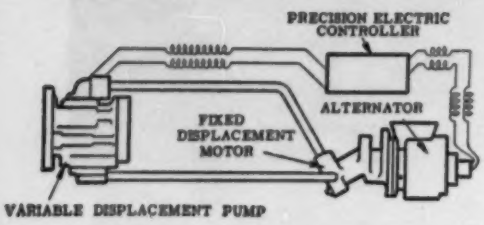

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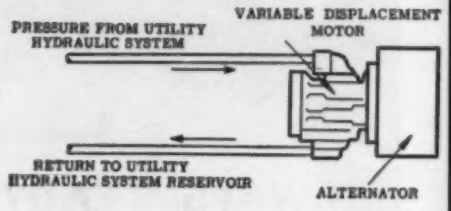

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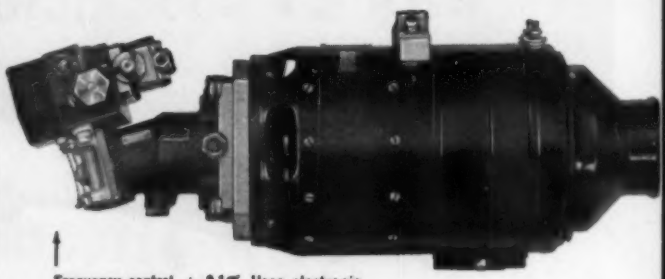

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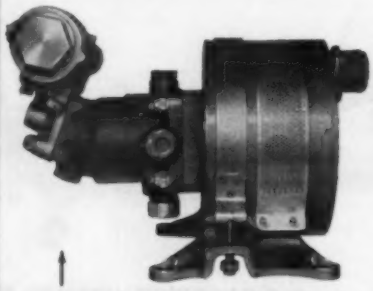

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PICTURE CREDITS

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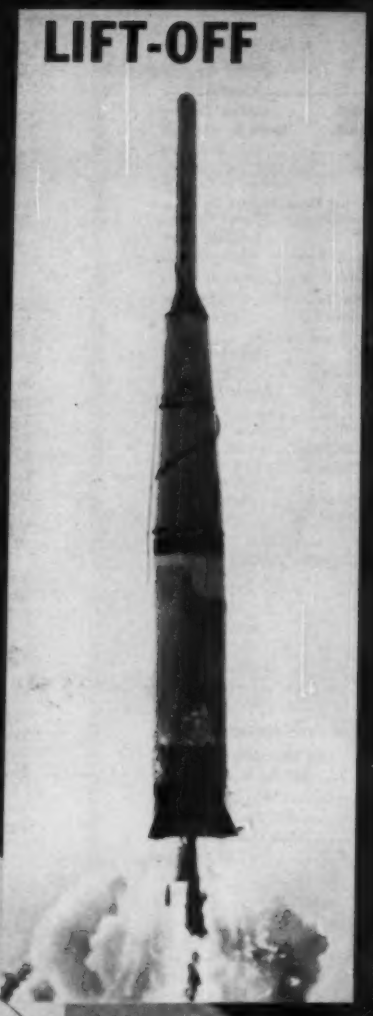

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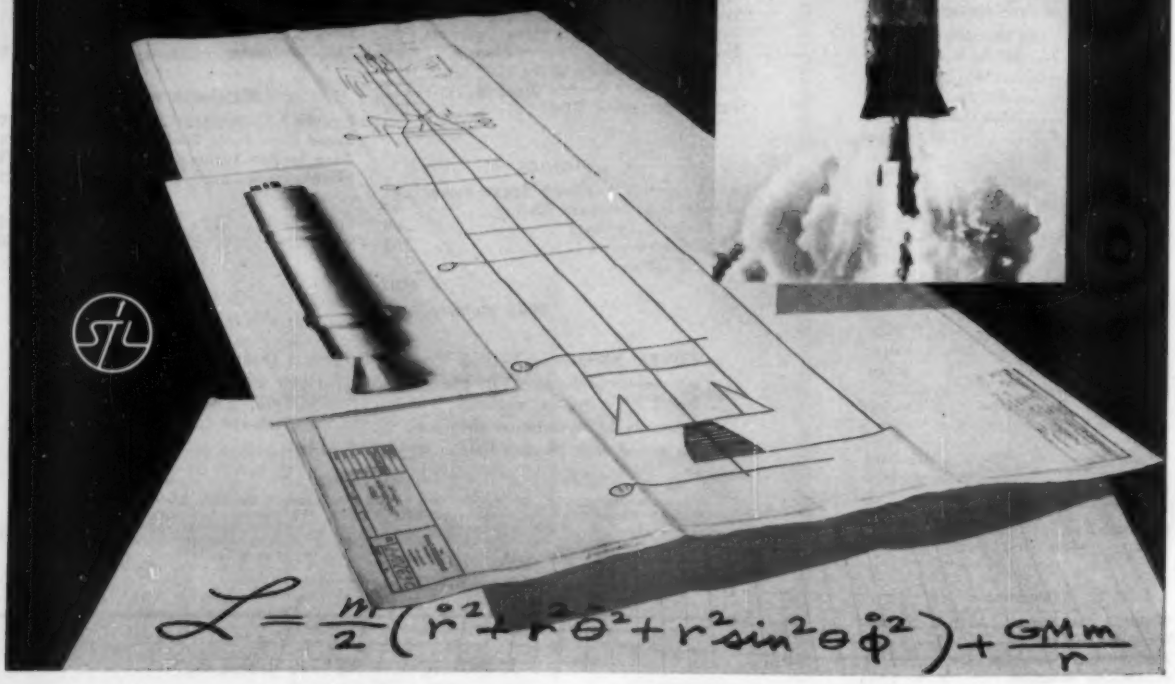


EDITORIAL

More Monkey Business

For the past few months there has been considerable furor between the Pentagon and the Congress on just how secret the use of Indian rhesus monkeys in space and medical research should be and just how prejudicial to the nation's welfare disclosure of this information might be. If this all sounds ridiculous, it is because it really is.

But this monkey business is worth exploring in some detail because it is symptomatic of how peacetime censorship and government thought control are being practiced by some Pentagon officials. It also affords a rare look into the alleged reasoning process behind many of their more ludicrous decisions.

The current monkey business started with a complaint to Congress by the Dayton Daily News that the Pentagon was withholding information on the use of monkeys in space experimentation on the ground of military security. Rep. John Moss (D.-Calif.) whose House Government Information Subcommittee has done such a valiant job of exposing the official withholders of public information, investigated the Dayton paper's complaint. This simple inquiry produced an indignant explosion from the Defense Department's general counsel, Robert Dechert, whose letter of reply accused the Moss committee of everything from aiding the Communist cause to stealing Pentagon secrets.

Among other things, Mr. Dechert wrote the following gem about the monkey business:

"It is our belief that your committee's action in this matter not only has served to discourage respect for the security system but also the only real beneficiaries can be the Communist propagandists who want to stir up trouble between us and other nations."

Mr. Dechert also said the basic correspondence on this Defense Department policy must remain "confidential" and even the name of "another government agency involved" (State Department) was classified. Mr. Dechert was also joined in these loud wails of "security breach" and "offering aid and comfort to the enemy" by Murray Snyder, assistant secretary of defense for public affairs, who stoutly defended this viewpoint before the Aviation Writers Assn. convention in Washington last May.

Now what lies behind all of this Defense-State Department hush-hush that the American people can't be told for fear of undermining our defense posture and foreign policy? It is simply that these rhesus monkeys are imported by the planeload from India for use in important space and medical research and that in India, a land of many religions, there are some groups that would be offended by this use of an animal they hold in high regard. The State-Defense Department theory was that any disclosure of this fact would arouse Indians against the United States and endanger our relations with India.

The theory also was apparently held (we will never know because the documents on this subject are still "confidential") that the Communists would use this fact as propaganda to create a rift between the U.S. and India. This hysteria reached such a peak that when the time came to fire two monkeys into space in an Army Jupiter missile a frantic search was made for true-blue native U.S.-born monkeys for the task to avoid any offense to Indian monkey worshippers. A Kansas-born rhesus was finally used.

All of this Defense-State Department hypothesis implies that this country must be doing something the Soviet Union is not. Otherwise how could the Russians turn this policy to our disadvantage? Is this hypothesis true?

For the answer I suggest that Mr. Dechert, since he is leaving the Defense Department and now should have ample time, Mr. Snyder and the State Department officials who collaborated with him on this policy take up a vigil on the airport steps at Tashkent, the capital of the Uzbek Soviet Socialist Republic and the gateway of international air traffic between the Soviet Union and India. If they watch long enough they will see twin-jet Tu-104 transports roar up to the servicing ramp and disgorge only a few Russians in long white coats. But these white-coated Russians will not be the only passengers in the jet fuselage that normally seats 70 human passengers. Inside are eight tons of rhesus monkeys being flown from India to Moscow for use in all types of medical research including the space program.

Surely this must be a tightly held military secret protected by a Soviet security screen, but we decided to try to check the facts with Aeroflot, which has a monopoly on the monkey hauls between Delhi and Moscow.

"Certainly we carry monkeys out of India" the Aeroflot officials told us. "It is very profitable business. We charge the Soviet government 11,000 rubles a flying hour to charter a Tu-104 with an eight-ton monkey load from Delhi-Moscow.

"There are a doctor and four attendants with each load of monkeys."

We checked the story with medical men in Moscow. "Certainly we use Indian monkeys in research," they reported. Some of the institutes in the Moscow area use 15-20 monkeys a day in their activities. One British correspondent, with whom we talked, had recently been chased to Tashkent by his London office to investigate a report that an Abominable Snowman had strayed from the Pamir peaks and was terrorizing Uzbekistan. Investigating on the spot, the British reporter found the animal actually involved had shrunk to a rhesus monkey that had escaped the vigilance of his keepers while a Tu-104 was parked at Tashkent airport. He viewed the remains of the rhesus that had been treed and shot by an Uzbek tribesman.

This research on the rhesus in the USSR raises some interesting questions about the still highly classified Defense-State Department monkey business that we hope Mr. Moss will refer to the Pentagon.

If the Soviet Union is importing monkeys from India for the same research purposes as the U.S., how can this fact possibly be used by Communist propagandists, as Mr. Dechert so clearly suggests?

Do the Pentagon and State Department know the Soviets are engaged in importing rhesus monkeys from India by the eight-ton, Tu-104 load? If so, is this information "classified" and does it require withholding from the American people?

If State-Defense don't know, how can they formulate "defense" policy without even the elementary facts of the situation involved at their command?

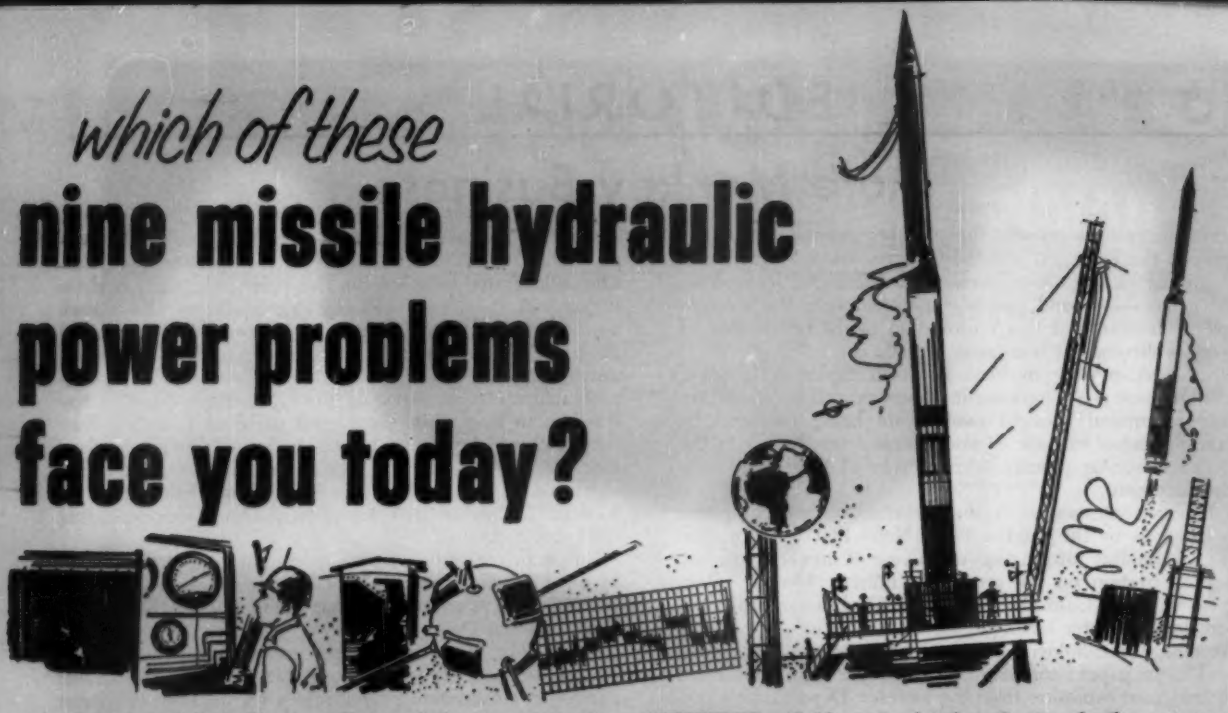
If they do know, why are they using this situation as an excuse to withhold information from the American public on the grounds that this is information "the publication of which could be prejudicial to the defense interests of the nation."?

Clearly the suggestion of Mr. Moss that Mr. Dechert "do a little more homework and jump to fewer conclusions" is in order. And perhaps this whole ludicrous business of official monkey business can be useful in exposing the activities of a group of poorly informed bureaucrats who are trying to do the American people's thinking for them.

—Robert Hotz

which of these

nine missile hydraulic power problems face you today?



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PROBLEM

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PROBLEM

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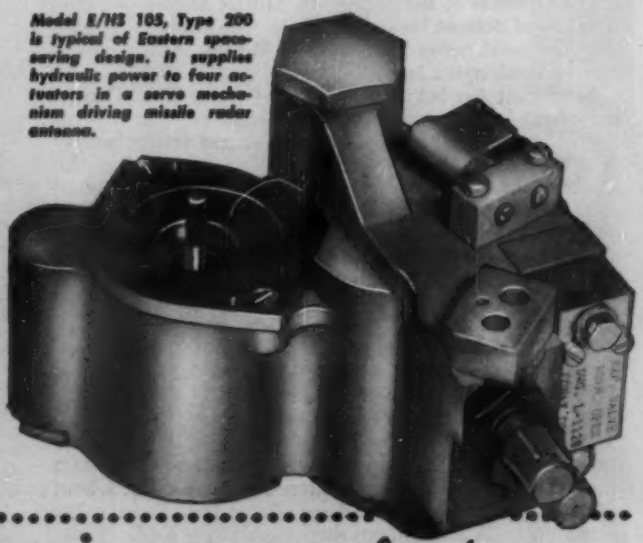

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WHO'S WHERE

In the Front Office

T. F. Walkowicz, an associate of Laurance S. Rockefeller, a director of Allied Research Associates, Inc., Boston, Mass., subsidiary of Vertol Aircraft Corp. Also: **Daniel J. Fink,** Allied's chief engineer, elected a vice president.

Capt. Robert C. Truax (USN, ret.), director of advanced development, Aerojet-General Corp.'s Liquid Rocket Plant, Sacramento, Calif.

Emerson W. Conlon, Assistant Director of Aeronautical and Space Research (powerplants) for the National Aeronautics and Space Administration, Washington, D. C. Mr. Conlon succeeds **Addison Rothrock,** now Scientist for Propulsion in NASA's Office of Program Planning and Evaluation.

Lawrence F. Zygmunt and **Harry L. Mitchell,** directors of Airwork Corp., Millville, N. J. Mr. Zygmunt is president and Mr. Mitchell vice president-treasurer of General Aircraft Supply, now a subsidiary of Airwork.

C. Reed Cary, board chairman, Leeds & Northrup Co., Philadelphia, Pa. **Daniel H. Schultz** succeeds Mr. Cary as senior vice president. Also: **George E. Beggs, Jr.,** executive vice president and a director.

Dr. James L. Goddard has been appointed Civil Air Surgeon of the Federal Aviation Agency, Washington, D. C. Also: **Dr. John E. Smith,** Chief of the Research Requirements Office of the Civil Air Surgeon.

Sundstrand Corp., Rockford, Ill., has announced the following appointments: **Carl L. Sadler,** vice president-Aviation and Defense Products Group; **P. A. Anderson,** director of aviation and defense products sales; **Donald L. Cauble,** manager, and **E. W. Kruger,** chief engineer, Sundstrand Aviation.

L. M. Craft, executive vice president-operations, Collins Radio Co., Cedar Rapids, Iowa. Also: **Robert T. Cox,** vice president in charge of the Cedar Rapids Division; **L. E. Bessemer,** vice president in charge of the Texas Division.

Honors and Elections

The 1959 M. Barry Carlton Award of the Professional Group on Military Electronics of the Institute of Radio Engineers has been presented to **Robert S. Grisetti** and **Earle B. Mullen** of General Electric Co.

John W. Crowley, Jr., former Director of Aeronautical and Space Research for the National Aeronautics and Space Administration, has been awarded NASA's Distinguished Service Medal for "outstanding leadership in aeronautical science." Mr. Crowley is the first person to receive the award.

Massachusetts Institute of Technology has announced that the AVIATION WEEK Fellowship for 1959-60 has been awarded to **Frederick K. Browand,** graduate student, and a member of the Massachusetts Institute of Technology Aeronautical Department Honors Group.

(Continued on page 135)

INDUSTRY OBSERVER

► Feasibility of using extremely high power microwave radiation to neutralize or detonate a ballistic missile's nuclear warhead at distances of 1,000 mi. or more by detonating its nuclear warhead or by overheating the nose cone, is under investigation by Varo Manufacturing Co. under Air Force contract. This is believed to be the "death ray" to which Advanced Research Projects Agency Director Roy Johnson has referred in congressional testimony and speeches. General Electric and Raytheon were unsuccessful bidders for the Air Force contract.

► General Electric J79 turbojets for Lockheed F-104Gs to be manufactured in Canada (AW July 6, p. 33) are scheduled to be built, under license, by Avro's Orenda Engines, Ltd., manufacturer of the 20,000 lb.-thrust class Iroquois turbojet designed for the recently canceled Avro Arrow CF-105.

► Watch for Cessna Aircraft Co. to soon offer a four-place commercial version of its side-by-side T-37 jet trainer now in use by the Air Force. The small jet is powered by two Continental J69-T-9 turbines generating 920 lb. thrust each.

► Pratt & Whitney will deliver the first J57 turbofan engine (TF-33-P1) to Boeing Airplane Co. in June, 1960. This means Boeing can fly the first B-52H bomber anytime after that, probably early next summer. If the Air Force likes the idea, earlier B-52s can be retrofitted with fan engines with kits and probably with some beefing up to handle the extra weight. The B-52H is the first airplane designed specifically for the Hound Dog missile.

► Prototypes of Dornier Do-29 STOL and VTOL research aircraft (AW June 1, p. 87) should be ready to fly this month or in early August. Numbers 2 and 3 prototypes are in advanced production in Munich. Dornier feels that two to three years of development work are necessary for the plane.

► Next major electronic support system program to be launched by Air Force may be its North American Air Defense Command Operations Center, identified as 225-L, which will give NORAD headquarters a comprehensive display of air defense situation and status of weapons at its disposal. Program is in the Pentagon awaiting top level approval.

► Extra wing fillet fuel tanks and 16-in. wing-tip extensions have been added to the Douglas DC-8 jet transport to bring performance up to specification values. Early planes in the test program were slightly under specified performance. In some models, the gross weight will be raised as much as 15,000 lb.

► North American A3J Vigilante, Navy's twin-jet attack plane, has successfully ejected, in a rearward direction at supersonic speed, its internal store carried in the fuselage.

► Boeing Bomarc IM-99B interceptor missile will have its ramjet powerplants cut in when it is boosted by a solid-propellant motor to an altitude of appproximately 8,500 ft. and speed of about Mach 0.6.

► Arthur D. Little, Inc., research firm will conduct a 60-day study of the entire boron fuel situation under Department of Defense sponsorship. Study is a supplement to a U. S. Air Force survey, since liquid boron fuel probably will be used in the afterburner of the General Electric J93 engine to extend the range of North American's B-70 and F-108 aircraft. Word is the study may place special emphasis on operational capabilities of Olin Mathieson and Callery Chemical Co. Meanwhile, cancellation by U. S. Navy of its contract with Metal Hydrides for sodium borohydride will not affect Olin Mathieson's high energy boron fuel program. Company was using the boron intermediate to manufacture HEF-2 in the pilot plant it operated for Navy at Model City, N. Y. (AW May 19, 1958, p. 29). Original plans called for this plant to be phased out when large HEF-2 plant Olin Mathieson will operate for USAF starts in October or November. It is believed enough sodium borohydride is on hand to last until then.

....RADAR SIGNALS FROM SPACE....

When man first rides a rocket into the fringes of our atmosphere, tracking stations on the ground will know his position and trajectory from signals beamed to earth by a tiny radar transponder.

This Stavid-designed and Stavid-built beacon receives transmissions from tactical radar sets on the ground and develops coded pulses for identification and tracking. The system provides for the passage of data in both directions, and permits tracking at greater distances than ever before. This development represents new gains in miniaturization techniques achieved by Stavid engineers, who are steadily advancing the state-of-the-art in electronics systems engineering.

Stavid Project Engineer, W. L. McCULLOH, has 10 years' experience in the development of airborne electronics, including: X and S-band Beacons, Radar Toss Bombing, Airborne DME and ranging and coding circuitry.

OTHER AIRBORNE PROJECTS INCLUDE:

- High-power Modulator-Transmitter for Radar Set AN/APQ-71
- Search and Bombing Radar QA-2003 (XN-1)/ASB
- All-Weather Radar Toss-Bombing System

STAVID Engineering, Inc. Plainfield, New Jersey

Imaginative Electronics...

Outstanding engineers and scientists are invited to inquire into opportunities on Stavid's advanced systems engineering teams.

Washington Roundup

Killian's Swan-Song

Dr. James R. Killian, retiring special assistant to the President for science and technology, remains firmly opposed to a "fly-early" nuclear propelled aircraft program. In his swan-song remarks to the National Press Club, Killian warned against "crash or prematurely expedited programs to achieve quick results when we do not yet have the basic understanding or have not yet done the underlying development and evaluation which will ensure a desirable, successful end result." As an example, Killian said "it has not seemed wise to undertake prematurely to stage a flight demonstration with a nuclear-powered aircraft without first having solved some of the basic technical problems, such as achieving adequate high-temperature materials, which would make it possible to build a nuclear-powered aircraft that would have really useful performance."

Nuclear Plane Hearings

. . . Meanwhile, the Research and Development Subcommittee of the Joint Congressional Committee on Atomic Energy—which for years has fought a losing battle for a "fly early" aircraft nuclear propulsion program—has scheduled public hearings on the Administration's new "go slower" program for July 23.

Public hearings, originally set by the subcommittee for February (AW Feb. 16, p. 32), were suspended while key administration officials, headed by the late Donald Quarles, Deputy Secretary of Defense, received further briefings on the program. Subsequent review of the program by the new Deputy Secretary of Defense, Thomas S. Gates, and Dr. Herbert York, Defense Department's director of research and engineering, resulted in a revised program shifting emphasis to research on new materials and canceling plans for a flight project (AW June 29, p. 17).

First witnesses will be Maj. Gen. Donald Keirn, assistant USAF deputy chief of staff for nuclear systems, and Air Force Secretary James H. Douglas. They will be followed by John A. McCone, chairman of the Atomic Energy Committee, who favors USAF's "fly early" plan. Then the opposition, Navy Department and Dr. York, will testify.

Surplus Aircraft Disposal

Long-awaited report by the Air Coordinating Committee on disposal of surplus transport aircraft called for federal action to aid in financing problems. Question of whether a free market should be allowed to set a pattern for disposal of the planes in foreign countries delayed release of the completed research more than six months. The committee recommended that private enterprise should handle surplus sales abroad with government backing wherever possible. Calling for a statement of government policy on the problem, committee members also urged that disposal of surplus planes by the military be closely regulated to prevent depressing the market.

Navy Pricing Practices

Spotlight this week will be on Navy pricing practices when General Accounting Office makes a presentation on the cases it has investigated to the House Armed Services Investigating Subcommittee at hearings starting July 14.

General Accounting's presentation on the Air Force, which showed a total over-pricing of $30 million on 14 contracts (AW June 8, p. 26), spurred Congress to turn down all amendments favorable to industry in extending the renegotiation law and launch an investigation of the hiring of former military officers and influential government officials by defense industries (see p. 35).

Meanwhile, the House voted to increase General Accounting's Fiscal 1960 budget by $2.8 million over Fiscal 1959, and the matter is now pending before the Senate. The increase would give GAO $41.8 million for the current fiscal year.

First Air Express Tariff

Domestic airlines have filed an air express tariff with the Civil Aeronautics Board for the first time since the industry's participation in express service with the Railway Express Agency began. In the past, all tariffs have been filed by Railway Express. The airline industry now is awaiting opening of negotiations on a renewal of a contract which will expire July 31. Meanwhile, Railway Express has submitted a proposed reorganization plan for the agency to member railroads, since some railroads have expressed dissatisfaction with the agency under its present system of operation.

As a result, the airline industry decided to file express tariffs to prevent any interruption of air express service if the negotiations with Railway Express are not completed by July 31. In filing the tariff, the industry is not casting doubts over the future of Railway Express but is making the move as a means of strengthening airline identity in the express market. Most carriers feel that, in the past, air express service has carried a strong suggestion in the shipping public's mind of railroad domination.

Dyna-Soar Deferred

U. S. Air Force, continuing its policy of heavy secrecy surrounding the Dyna-Soar hypersonic aircraft project, last week deferred announcement of a contract award, saying only that selection is "pending completion of further studies of various aspects." The project originally was to have been announced by the close of the fiscal year (June 30). Teams involved in Dyna-Soar have been formed by Boeing Airplane Co. and the Martin Co., in conjunction with Bell Aircraft Co.

Air Transport Utilization

Senate Appropriations Committee, in reporting the Fiscal 1960 defense bill, urged the Department of Defense to adopt an Air Force policy of utilizing air transportation as a means of reducing in-transit time for personnel and cargo. Mobility and economy will result if the services recognize the specific monetary value of time saved in the evaluation of transportation costs, the senators said. At the same time, the committee urged greater utilization of certificated all-cargo carriers on routes assigned by the Civil Aeronautics Board, both domestically and internationally. Revenues from this source, the committee said, should encourage the all-cargo carriers as well as the supplemental carriers to develop new types of cargo equipment in preference to adding such aircraft to the Military Air Transport Service fleet at government expense.

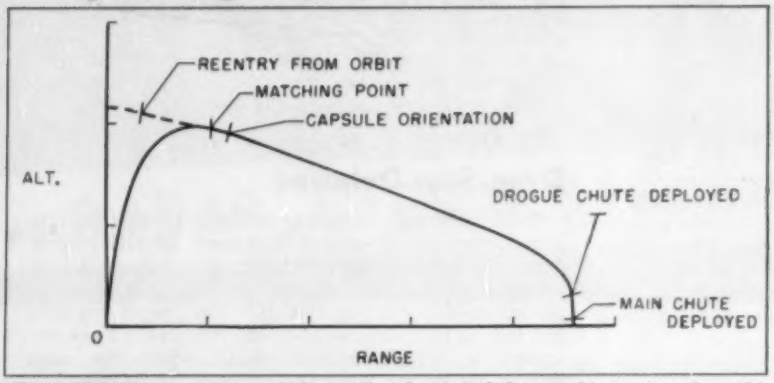
—Washington staff

WATER forced through the escape system nozzles tests the effect of the system's power on the stability of the Project Mercury capsule. Tests are made on a one-sixth scale model in NASA's 7 x 10 ft. tunnel at the Langley Research Center.

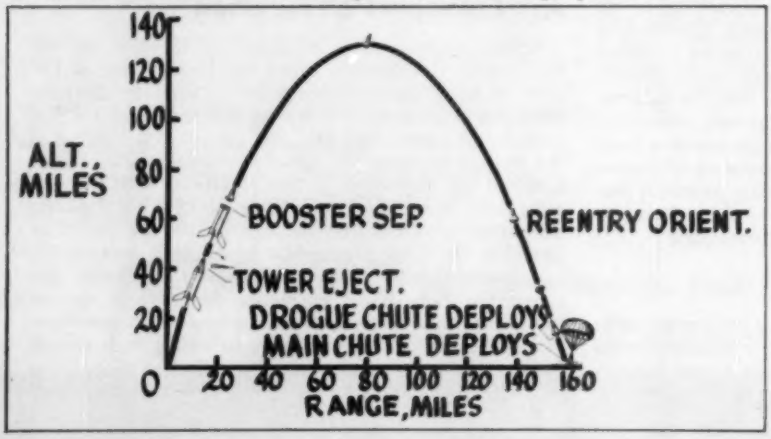
Space Technology

Flexibility Highlights Mercury Program

Jupiter booster role undetermined pending studies; capsule design stays open for possible modification.



ATLAS BOOSTED re-entry test flight profile (above) includes matching point where this trajectory reaches the same conditions that would be met in orbital flight. Altitude is distorted, should be about 10 times the range scale. Little Joe flight plan is shown (below).



Langley Field, Va.—Continuing need for flexibility in the Project Mercury man-in-space program was demonstrated here last week by disclosures that one of four major types of test vehicles may be eliminated and that capsule design still is not completely frozen.

National Aeronautics and Space Administration Space Task Group has told Army Ballistic Missile Agency to hold up procurement of the two Army-Chrysler, Jupiter missile boosters now on order pending some additional study.

Increasing Reliability

Desirability of using as few different types of vehicles as possible and of increasing reliability by using the final booster as often as possible with the entire system are considerations in the study.

The final booster is the USAF-Convair Atlas. Another consideration is limited usefulness of the Jupiter compared to its cost.

Undetermined role of Jupiter and continuing re-evaluation of the way in which the Army-Chrysler Redstone will be used in manned suborbital flight emphasized the careful approach the Task Group is taking to what it considers the first step in a completely new realm of man's flight.

Increase Atlas Role

Elimination of Jupiter as a test vehicle would increase the role of Atlas but would not necessarily speed up the testing program. Delays in the missile's test firing schedule (AW July 6, p. 27)

already have caused postponement of NASA's Big Joe shot, a test of re-entry hearing effects on capsule components launched by an Atlas.

First tests that will simulate closely the dynamic forces of launch and re-entry will begin this summer with firings of the Little Joe vehicle (see p. 31) from Langley Research Center's Pilotless Aircraft Research Station at Wallops Island, Va., 70 mi. from here.

Following research and development launchings, the final shot in the series of six Little Joes will be an attempt to qualify the McDonnell Aircraft Corp.'s Mercury capsule.

Design of the capsule still is undergoing minor changes following wind tunnel testing of more than 60 models of capsules, boosters and capsule-boosters and firings of various shapes at Wallops.

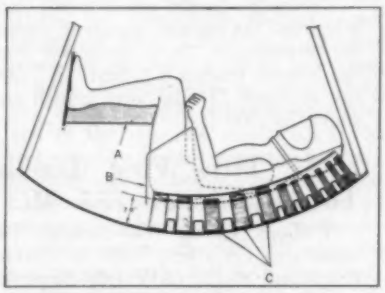
One major design feature still unsettled is the type of heat shield that will be used. Both ablating and beryllium heat sink shields still are being evaluated. Although the two techniques can be used in combination, they will not be used this way in Project Mercury. If the ablation technique is chosen, the material probably will be a glass fiber and phenolic resin combination quite similar to that used in the Jupiter nose cone.

External configuration changes include addition of a truncated conical section to the constant-section cylinder which forms the after portion of the capsule. A high cobalt alloy forming the very thin outer shell of the small portion of the Mercury vehicle now will be corrugated to add strength. This alloy will withstand temperatures up to 1,600-1,700F.

Design of the molded glass fiber couch that will support the space pilot also has been modified. Couch now stops at mid-thigh, and cushioning material will be placed under the pilot's calves and feet. Experimental models of the couch have been molded to fit each of the seven Mercury pilots and they will ride these in simulated missions in Navy's Johnsville centrifuge.

SCHLIEREN photograph of the Project Mercury space capsule and escape system shows the flow on a one-ninth scale model at Mach 3.94.

ONE-NINTH scale model shows details of the pylon mounted escape system for Project Mercury. The system calls for use of three solid propellant motors.



LANDING cushioning for capsule pilot includes (a) cushioning, (b) replaceable couch molded to the individual pilot, and (c) crushable honeycomb section.

The couch is supported directly by 7 in. of crushable aluminum honeycomb material which will start to collapse at the 45g level expected if the capsule made a hard ground landing. The material also will crush evenly.

The capsule has two entirely independent reaction jet control systems with their own exhaust ports, hydrogen peroxide supply systems, etc. One is operated by the autopilot, and the other by the pilot, who uses a sidearm controller. After the launch phase, yaw jets located on the small end of the capsule are used to rotate the capsule 180 deg. on its vertical axis. This puts the heat shield forward and leaves the pilot facing backward.

A rocket pack on the heat shield in-

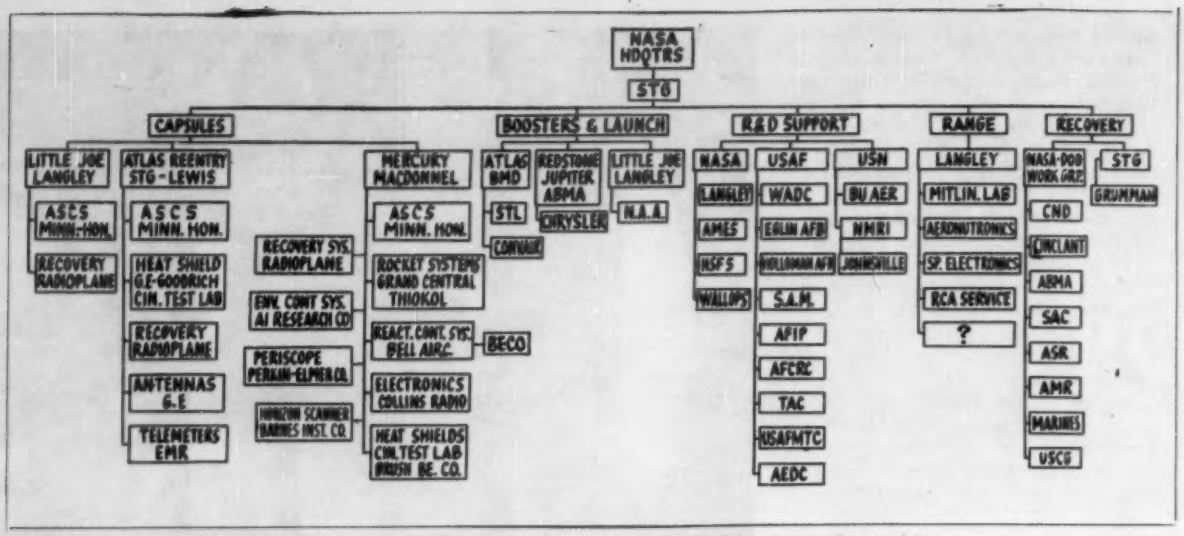


CHART shows organization of NASA's Project Mercury and the contractors involved in various phases of it.

Astronaut Training Program

COMPLETED ACTIVITIES

McDonnell Visit:

1. Capsule Familiarization.

Wright Air Development Center:

1. General Pressure suit indoctrination.
   (A) Centrifuge ride using Redstone and Atlas launch profiles.
   (B) Re-entry heat profile with suits unpressurized but vented.
   (C) Pressure chamber run to 100,000 ft. with suit pressurized.
2. Check of low residue diets for three days.

Naval Medical Research Institute, Bethesda, Md.:

1. Determination of basal metabolic rate, cutaneous blood flow rate, and sweat rate at environmental temperatures of 95F and 114F.
2. Familiarization with the effects of excessive CO_2.

Visit to Cape Canaveral:

1. Familiarization with the organization of BMD and AMR.
2. Study of launching procedures and missiles under development at Cape Canaveral.

Witness of Capsule Recovery Operation on Board a Naval Destroyer:

1. This recovery took place at sea when the capsule was dropped from a C-130 from an altitude of 20,000 ft.

Skin Diving Training at Navy Little Creek Amphibious Base:

1. To simulate the effects of the weightless state and maintain physical fitness of the astronauts.

Visit to Army Ballistic Missile Agency:

1. This trip was to familiarize the astronauts with the Redstone missile.

SCHEDULED ACTIVITIES FOR THE FUTURE

1. Continuation of studies in space mechanics and sciences.
2. Continual participation in the vehicle development program.
3. Continuation of flight and simulator training.
4. Acceleration studies with centrifuge at Johnsville.
5. Participation in R&D launch and recovery activities.
6. Trip to Convair, San Diego, for familiarization with the Atlas booster.
   (A) Tour of plant facilities.
   (B) Study of Atlas construction and operational procedures.
   (C) Discussions with Convair engineers.
7. Visit to McDonnell for checkout procedures and training.
8. Fittiags for pressure suit at contractor's plant.
9. Survival, disorientation, and communications training at Pensacola.
10. Trip to Edwards AFB for X-15 briefing.
11. Flights for practice in eating and drinking in the weightless state.

cludes small separation motors to free the capsule from its booster. They impart 15 fps. additional velocity to the capsule. The pack also includes three small retrorockets for initiating re-entry. The capsule flies in orbit with a slightly nose-up attitude and is tilted upward another 30 deg. for retrorocket firing. Control system then returns the vehicle to flight attitude and descent is begun.

Retrorockets are fired by a timer which is set before launching. The timer firing program can be reset at any later time on the basis of new orbital information. The pilot also can fire the retrorockets if he desires.

In order to design the rocket-powered capsule escape system, histories of booster malfunctions are being carefully studied to determine how to sense impending trouble in the pre-launch and launching phases. Study of the Atlas history indicates there has been about 5 sec. of advance warning before each failure. This would be enough time to actuate an escape system. Task Group officials said they are confident that a good abort-sensing and escape system could allow a pilot to free his capsule on any Atlas failure.

The escape pylon can free the capsule from the booster anywhere within the atmosphere. It is jettisoned after the booster reaches a velocity of 7,000 fps. at about 2¼ min. after launch and above 200,000 ft.

USAF Fires First Javelin To Altitude of 755 Mi.

Wallops Island, Va.—Aerolab Development Co.'s first 7,400 lb. Javelin test sound rocket (AW July 6, p. 87) was fired here last week to an altitude of 755 mi. by an Air Force Special Weapons Center team. Planned altitude was 750 mi.

First RAF Thor Sites Nearly Operational

By Cecil Brownlow

Feltwell, England—First five of 20 Douglas Thor IRBM sites planned for the British Isles will become fully operational under Royal Air Force control within the next few weeks with USAF retaining authority only over nuclear warheads. All sites are scheduled to be fully manned by RAF crews by next March.

Five sites moving into truly operational status comprise the first of four RAF missile units now being trained by USAF and technical representatives, including Douglas Aircraft Co., AC Spark Plug and General Electric.

The unit, which has a total of 15 missiles, is headquartered at Feltwell with four satellite sites spotted at stations located between 20 and 30 mi. apart. Each site, including Feltwell, has three missiles and three launch pads.

A second RAF Thor unit and its five sites headquartered at Hemswell is scheduled to become operational under RAF control in September—the third at Driffield in December and the fifth in central England in March. All units are under the jurisdiction the British Bomber Command. Scheduled dates may slip slightly—Feltwell is missing its target by approximately one month—but top officials of both USAF and RAF are convinced they will be substantially attained.

Last Dec. 31, the date set by U. S. Defense Secretary Neil McElroy for the Thor to achieve some combat capability in England—the Feltwell complex possessed a limited "emergency operational capability," according to Maj. Gen. William H. Blanchard, commander of Strategic Air Command's Seventh Air Division in England which oversees Thor training here.

"Emergency operational capability," as described by Gen. Blanchard, means that a missile could have been fired from Feltwell site, if the need had arisen, by combining resources and talents of RAF, USAF and Douglas personnel stationed here at any time.

Ratio of American personnel here has been declining steadily since the first of the year and almost all U. S. technicians will have departed by early August, leaving behind an Air Force complement of 53 officers and men to retain control over nuclear warheads. At the moment, the Feltwell complex has approximately 850 RAF personnel, another 350 from USAF.

Despite the slight slippage in schedule at Feltwell, both Gen. Blanchard and top British Ministry of Defense officials say they have been "amazed" by rapid progress in construction and training of RAF crews made since the time the United States-United Kingdom decision was reached to station Thor in England.

Feltwell, a former Flying Training Command station, saw its last Hunting Provost take off from the grass strip here on May 17, 1958. Concrete had been poured by September, and Douglas technicians—their total here reached 1,000 at one point—swarmed in to install necessary instrumentation. The initial Thor was erected on its launcher by the Douglas crew on Thanksgiving Day.

The training schedule has kept the same fast pace, with operational and technical crews sometimes working on into the early hours of morning. Thus far, crews at Feltwell's five sites have erected their Thors in simulated launchings slightly more than 500 times. In demonstration here last week, an all-RAF crew had its missile ready for launch within 19 min. after the order to fire was given. The other two crews at the station had their missiles ready seconds later. The goal of crews from order to launch is 15 min.

Sites are manned here on a 24-hr. basis with a USAF officer always on hand to release a nuclear warhead if such an order should ever be transmitted from the President by way of coded message over direct line with Strategic Air Command headquarters in Omaha, Neb.

Actually, his presence is largely symbolic. Nuclear warheads already are mounted in the nose cones of the missiles ready to go.

Bearing the cumbersome designation of "authentication officer," his physical authority lies in a single key, often carried on a string around his neck, that must be inserted into the electrical system in the central control van for the three pads and turned before the circuit can be completed and countdown begun. Need for such a key obviously could be easily overcome, and both sides are operating primarily on a faith backed by close ties that each will adhere to its agreements.

The United States' apparent unwillingness to share such faith with the French is a source of much of the controversy touched off by President Charles de Gaulle over the proposed presence of U.S. nuclear weapons in France (AW June 29, p. 26). De Gaulle wants complete authority over such weapons but probably would accept an agreement similar to that with Great Britain whereby a mutual decision must be made before a Thor is fired.

Bringing the Feltwell complex to an operational capability has been accomplished in three basic steps—construction, installation and checkout and, finally, the training and operational phase.

All construction was completed here in December, and installation and checkout was wrapped up by June 1. The second Thor unit at Hemswell is now well into its second stage, and final construction was completed in June.

Training of RAF personnel for the first missile unit here at Feltwell has been unique. Operational and technical personnel were sent to the United States and trained on an individual basis by Air Training Command, Douglas Tucson and AC Spark Plug which manufactures the Thor's inertial guidance system. Vandenberg AFB, Calif., however, still had not reached the stage where it could offer crew training, so the groups were sent back to England and have been receiving "on-the-job" instruction in operations and maintenance from the 672nd Technical Training Squadron.

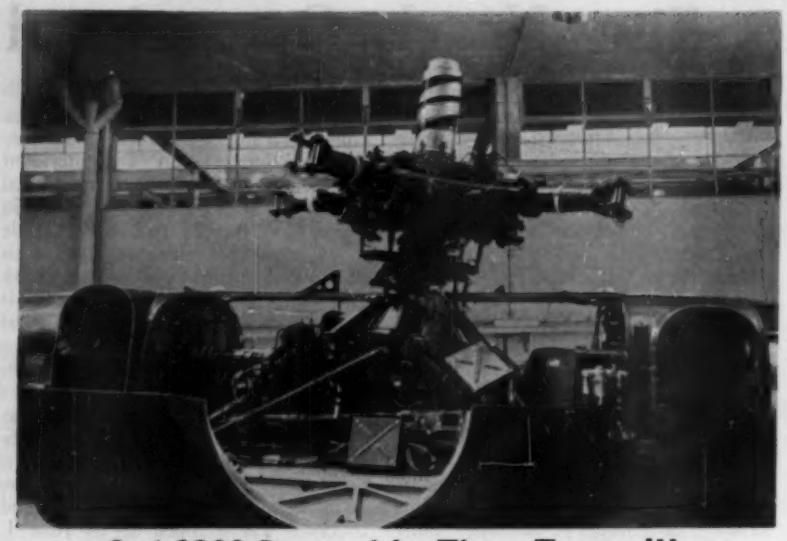
The 672nd, commanded by Col. W. A. Delahay, was formed in England for this specific purpose by Gen. Blanchard's Seventh Air Division and is in process of phasing out now that its job is virtually complete. The majority of its personnel is being reassigned to the United States to join Air Force's intercontinental ballistic missile program.

The other three British missile units are being completely trained in the United States for periods of up to approximately eight months, concluding their tour with actual firing of Thors from Vandenberg. Since there is no missile range in England capable of accommodating the 1,500-mi. range of the Thor, the Feltwell unit will return to the United States in the fall—after Hemswell attains an operational capability—to gain experience in just what happens when a missile is actually fired.

Partially as a safety precaution, partially as a public relations measure to quiet the protests of English pacifists and partially as move to minimize corrosion hazards, Thors here have not been, and may never be, fueled with RP-1 kerosene propellant.

Thor Hard Base Test

Washington—United States probably will launch a Thor intermediate range ballistic missile from an underground site within the next year in an effort to determine feasibility of hardening missile's operational bases. If the tests are successful, 20 Thor bases scheduled for Great Britain may be hardened or substantially toughened.



Sud 3200 Powered by Three Turmo IIIs

First detailed photographs of powerplant in Sud Aviation 3200 Frelon helicopter shows installation of three Turbomeca Turmo III free-turbine engines. Two are mounted ahead of rotor mast (at right in picture) and one is mounted aft. Engines are rated at 789 eshp. for takeoff; cruise specific fuel consumption is 0.756 lb./hp./hr. Frelon ("Hornet" in French) is designed for anti-submarine warfare, but the company hopes to sell the helicopter commercially with a capacity of more than 20 passengers. Frelon has a rotor diameter of 49.2 ft., weighs 16,550 lb. in military version. Over-all length of the helicopter is 47.6 ft. Endurance in hovering without ground effect is 3¼ hr., says the company, and range varies between 300 and 600 mi. depending on the amount of tank volume utilized.

Soviets Explore Helicopter Sales; Base Overhaul on 1,000 hr. Life

By Craig Lewis

Stratford, Conn.—Russian aircraft industry puts its new helicopters through a development program that ensures a 1,000 hr. overhaul life before they are delivered for military or airline use, according to Ralph Alex, president of the American Helicopter Society.

Indications that the Soviet Union may be preparing for a helicopter export sales effort along with the fixed-wing export program could be seen in Alex's observation that exploratory conversations have been held with various European operators concerning possible use of Russian helicopters. Alex also said the Russians asked whether the Federal Aviation Agency would certify the Kamov Ka-15, as well as some larger types, for use in the United States.

Alex reported to an AHS meeting here on a detailed tour of the Russian helicopter industry he made following the annual Federation Aeronautique Internationale meeting in Moscow (AW June 22, p. 86). Alex, who is head of the production design components section of Sikorsky Aircraft Division of United Aircraft Corp., said the Russians base ground and flight tests on a 1,000 hr. overhaul capability before the helicopters are released for service.

During his tour, Alex flew the Ka-15, a small, dual-rotor helicopter now in production. He said it flew well and is a "very impressive helicopter." The Ka-15 is a two-passenger aircraft with a 220 mi. range which was designed for mail and charter work. It weighs 1,760 lb. and flies at a 2,500 lb. gross weight.

The Kamov helicopter has a 250 hp. Ivchenko piston engine, uses a simple centrifugal clutch and has two three-bladed contrarotating rotors. Alex said the rotors were wood and "beautifully made," and, like other Russian helicopter rotors, the system had anti-icing provisions.

The Ka-15 has manual control, and Alex noted that there is no manifold pressure indicated on the panel, but only an indication of the pitch angle of the blade.

The Mi-4 is a single rotor helicopter with a 1,750 hp. piston engine in which Alex judged the parts are interchangeable with the Wright R1820. It has a single four-bladed rotor 65 ft. in diameter. The Mi-4 weighs 8,800 lb. empty and has a gross weight of 15,500 lb., and has an 11,000 ft. hovering ceiling at gross weight. Range is 300 mi., a general requirement for Russian helicopters.

No Safety Belt

In flying the Mi-4, Alex noted the absence of a safety belt, and said the Russian pilot discouraged any unusual maneuvers. Controls are run with a 3,000 psi. servo system. The helicopter was flown to a maximum of 120 mph. Alex noted that the heaters in the Mi-4 and Mi-6 were "Janitrol heaters without the label," although the Russians said they designed them.

The early Mi-4 had magnesium skin and magnesium structure in the fuselage, but Alex said the Russians had considerable trouble with corrosion and have switched to aluminum. Soviet engineers are using considerable titanium in the Mi-6. Alex said that 110 Mi-4 helicopters were built with magnesium skin and that more than 400 of them have been built with aluminum skin.

Record Attempt

The Mi-6 is a turbine-powered, single rotor helicopter which the Russians will use in an attempt to break international helicopter speed records (AW June 22, p. 91). The Mi-6 has already flown at more than 200 mph., according to Alex, and it is expected to reach 220 mph. within a few months.

Use of a wing to partially unload the rotor apparently is the answer to the speed performance of the Mi-6. A wing mounted high on the fuselage offers very little vertical drag, probably 10-15% more than the whole fuselage, and it unloads the rotor about 20%. Designers settled on the 20% figure after getting rotor instability at higher values.

The Mi-6 has two 5,500 hp. Soloviev free turbine engines driving a main rotor

Venus Space Programs

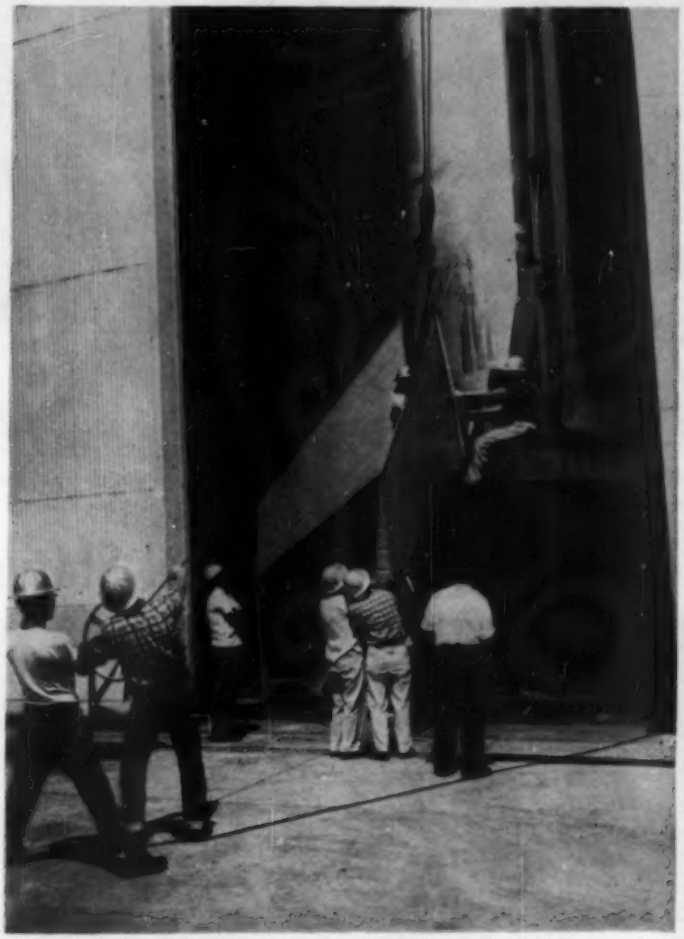
Washington—Atlas Able and Thor Able space probes originally intended for launchings toward Venus now are expected to be fired next fall or early winter, one as a moon orbiter and the other as an asteroid.

Shots probably will be fired only a few days apart and will carry almost the same payloads that would have been carried on the Venus mission (AW Mar. 23, p. 33). Thor Able will be sent into an orbit around the sun similar to that of Pioneer IV and Atlas Able will be an attempt to orbit the moon. Although launchings may come in October, the schedule is flexible, with emphasis on reliability rather than an early launching.

115 ft. in diameter and a tail rotor with a 20 ft. diameter. It flies at a gross weight of 71,000 lb. and weighs 45,000 lb. empty. Range is 300 mi. The helicopter is equipped with automatic stabilization equipment, as are all large Russian helicopters, and it can fly instrument flight rules down to 40 kt.

The Yak-24 is a tandem rotor machine with a 28,000 lb. gross weight, 300 mi. range and capacity for 40 passengers. Its two rotors and two 1,750 hp. engines are the same as those used in the Mi-4, and Alex observed that this interchangeability of parts and design ideas speeds the development cycle. The Yak-24 cruises at 117 mph. and has a maximum speed of 145 mph.

Unlike their new transport aircraft, the Russians haven't used turbine engines very widely in helicopter designs, and Alex said this was because turbine engines aren't available. He said that apparently the Russians aren't working very hard on development of small turbine engines.



COMPATIBILITY of Little Joe booster and launcher are checked on static test tower (left) by North American Aviation personnel. Model (right) shows configuration of 44.5-ft. booster-capsule combination. First shot will carry an empty Mercury capsule.

Space Technology

Little Joe Readied for Mercury Studies

Washington—First two of six Little Joe capsule launching rockets are to be delivered to National Aeronautics and Space Administration by North American Aviation's Missile Division this month and first firing is expected before the end of July. Other shots will follow at about six-week intervals.

The launcher was engineered, built and tested by North American in 4½ months and delivered ahead of schedule to NASA's Pilotless Aircraft Research Station at Wallops Island, Va., where launchings will be made.

Little Joes will be used to study parachute deployment on Project Mercury manned orbit capsules and to study biomedical effects of acceleration and water impact.

First shot will carry an empty capsule. Second, third and fourth are expected to carry Rhesus monkeys and the fifth may carry a chimpanzee. Sixth vehicle is a backup.

Booster plus capsule is 44½ ft. long with a maximum diameter of 6½ ft. It is powered by four Thiokol Castor rockets, which are improved Sergeants, and four Thiokol Recruits. Accumulated thrust is about 472,000 lb. Two Castors are fired at launch, giving 120,000 lb. of thrust. Less than half a second later, four Recruits fire, adding 132,000 lb. of thrust. After burnout of the Recruits and at the instant of burnout of the first two Castors, the two remaining Castors are fired.

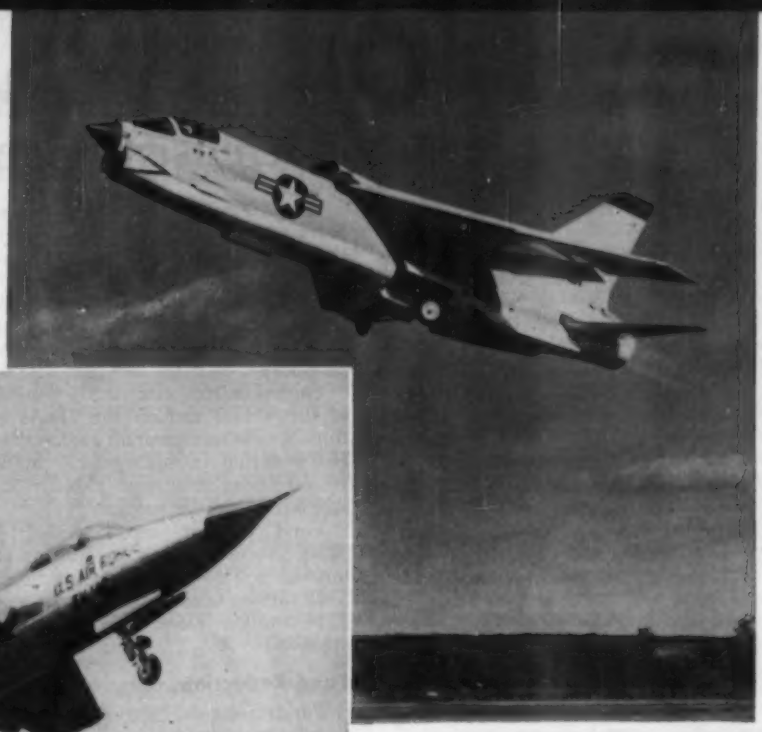
NASA has responsibility for firings and data collection. North American supplies launcher and boosters and technical services under a $400,000 contract.

First Republic F-105D Thunderchief is rolled out at Republic's Farmingdale, N. Y., plant. Changes include an extensively redesigned cockpit human engineered so that control knobs are placed for fingertip manipulation.

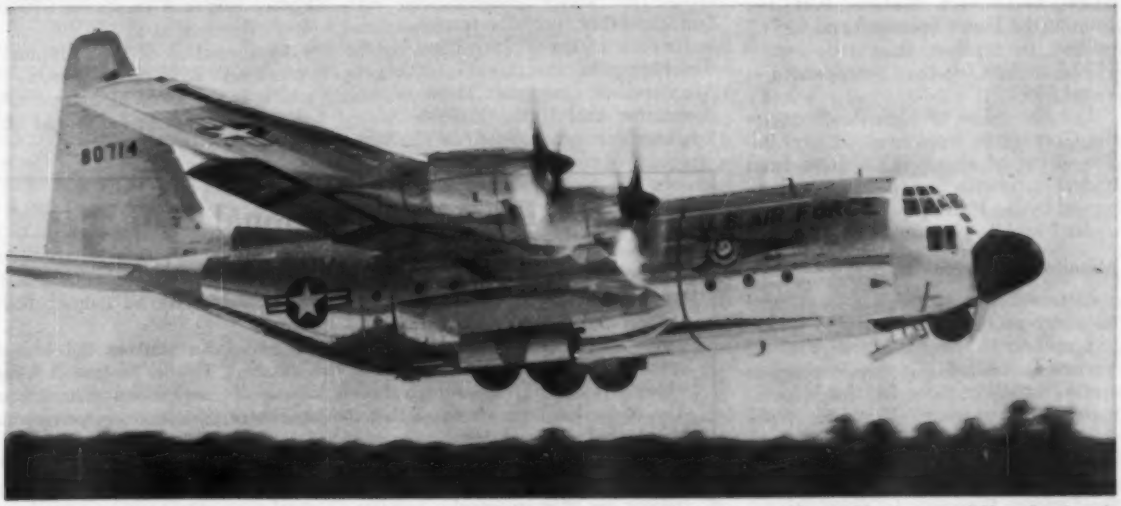
F8U-2, F-105D, C-130B Approach Operational Status

Production Chance Vought F8U-2 makes its first flight. The Navy day fighter is powered by a Pratt & Whitney J57P-16 rated at more than 10,000 lb. thrust. The F8U-2 has an air scoop on each side of the vertical tail for afterburner cooling.

Principal external change in the F8U-2 configuration is the addition of two non-retractable ventral fins (right). Bulk of the changes in the -2 are internal and involve new avionic gear. Armament includes 2-4 20 mm. cannon and 2-4 Sidewinder air-to-air missiles.



Major change in the F-105D, making its first flight (left), is addition of extensive avionic gear to give it all weather capability. Major external configuration change is lengthening of the nose 15 in. for added avionic gear stowage. Armament includes a 20 mm. General Electric Vulcan cannon that can fire 6,000 rounds per minute and has linkless ammunition feed. Tactical Air Command, which will get the first F-105D, is forming a second squadron of the F-105B day fighter-bomber. Avionic gear comprises seven automatic systems for navigation, ground mapping, etc. Powerplant is a Pratt & Whitney J75.



Lockheed C-130B turboprop transport is shown being delivered to Sewart AFB, Tenn. The 4,000-mi.-range, 360-mph. aircraft, which can airlift 135,000 lb., will gradually replace C-130As of the 463rd Troop Carrier Wing, 839th Division.

Senate Committee Stresses Ballistic Missiles in Revised Defense Budget

By Ford Eastman

Washington—Senate Appropriations Committee last week revised and sent to the Senate floor a Fiscal 1960 defense budget of $39.5 billion which places more emphasis on long range ballistic missiles and the ability to handle limited war situations.

The budget recommended by the committee is $346 million higher than requested by the Administration and $746 million over the amount approved by the House last month (AW June 8, p. 28), but it is $293.8 million less than appropriated for Fiscal 1959.

However, the $39.5 billion in appropriations, plus $450 million in transfer authority from revolving funds, would give the Defense Department more than $40 billion in new obligational availability for Fiscal 1960. Budget estimates called for $39.5 billion in new obligational availability, but this was cut to $39.2 billion by the House.

Service Shares

Under the committee recommended bill, Fiscal 1960 appropriations would be distributed as follows:

- **Air Force, $17.5 billion.** This is $301.6 million more than approved by the House, but $237 million less than requested and $452 million under the amount appropriated for Fiscal 1959.
- **Army, $9.2 billion.** This is $221.6 million more than approved by the House, $443.5 million more than requested by the Administration and $376.8 million more than appropriated in Fiscal 1959.
- **Navy, $11.2 billion.** This is an increase of $237.4 million over the amount the House approved and $154.7 million more than requested, but is $217.8 million less than appropriated in Fiscal 1959.

For the office of Defense Secretary the Committee recommended $1.3 billion, a cut of about $15 million from budget estimates and the amount approved by the House, but only $693,700 under Fiscal 1959 appropriations.

Missile Procurement

In missile procurement, the committee approved House action which added $85 million to the Air Force Atlas intercontinental ballistic missile program and $77 million more for the Minuteman ICBM program. However, it did so with the understanding that the additional funds might be applied to any area of the ballistic missile field in which the Defense Secretary deems additional funding is required for acceleration.

Added flexibility in programing was provided by the committee by giving the Defense Secretary authority to transfer funds from, but not to, the Air Force Boeing Bomarc interceptor missile program and the Army's Nike Ajax and Nike Hercules surface-to-air missile programs.

The committee restored $79.9 million of the $162.7 million the House cut from the Bomarc program and approved House action in adding $137 million to accelerate the Army's Nike Zeus anti-missile missile program.

Total amount recommended for Army procurement of equipment and missiles is $1.4 billion, an increase of $425 million over budget estimates and $217 million more than the House approved.

Fund Reduction

Funds recommended for Air Force missile procurement totaled $2.5 billion, an increase of $104 million over the amount approved by the House, but a reduction of $48 million from budget estimates.

To increase limited war capabilities, the committee recommended $380 million for a new nuclear-powered Navy aircraft carrier, an increase in Marine Corps strength and substantial sums for Army modernization.

For Army modernization, including Nike Zeus acceleration, the committee recommended appropriations increases of $405 million over budget estimates, plus $117.8 million from re-programing Nike Hercules funds.

The committee did not recommend the increase voted by the House to increase the Navy's anti-submarine warfare capability, nor did it recommend restoration of the $127 million cut by the House in the Air Force Martin Mace missile program. However, the committee said if the Defense Secretary considers procurement of the Mace essential, it recommends operation and maintenance, procurement and research and development funds be used.

Other recommendations include:

- **Additional $18 million** for long lead-time items in the Navy's nuclear anti-submarine submarine program.
- **Restoration of $24.5 million** deleted by the House for procurement of 35 jet utility training aircraft, and $23.4 million for 14 jet navigator training aircraft for the Air Force.
- **Additional $11 million** for the procurement of 11 Fairchild F-27 turboprop transport aircraft for the Air Force.
- **Approval of House Action** deleting $53.5 million for the procurement of 10 jet cargo aircraft for the Military Air Transport Service.
- **Increase from $80 million** recommended by the House to $100 million in funds available to MATS only for the procurement of commercial air transportation. The Senate Defense Subcommittee earlier had recommended $150 million for this purpose.
- **Restoration of $20 million** cut by the House from the Army's estimates for base operation costs and proficiency flying.
- **Appropriation of $4.2 billion** for Air Force operation and maintenance which is $34 million under budget estimates, but $55 million more than voted by the House.
- **Appropriation of $1.9 billion** for procurement of aircraft and related equipment by the Navy. This is the same as budget estimates but $19 million more than approved by the House.
- **Decrease of $10.8 million** in the Army research, development, test and evaluation estimates. Total recommended for this purpose is $1.035 billion. In the same category for the Navy the committee recommended $970.9 million, deleting the additional $45 million voted by the House. For the Air Force, this was increased $10 million over estimates to $1.159 billion.
- **Appropriation of $455 million** for the Advanced Research Projects Agency which is the same as budget estimates and the amount approved by the House.

Polaris Operational Date

Syosset, N. Y.—Polaris weapon system, the U. S. Navy's fleet ballistic missile, is scheduled to become operational in the fall of 1960—seven years ahead of the original operational date—according to Rear Adm. W. F. Raborn, director of the Navy's Special Projects Office.

Adm. Raborn was speaking last week at ceremonies marking the beginning operation of Sperry Gyroscope Co.'s new "Ashore Polaris Navigation Center" which is an exact replica of a Polaris submarine's navigational control center. The center has been set up so that the interrelated navigation equipments could be checked out and installation problems solved in advance of installation in the Polaris submarines now under construction.

The navigation control center will also be used by the Navy for the purpose of training operating personnel.

Gates Defends Officers in Industry Against Congressional Attack

By Katherine Johnsen

Washington—Deputy Secretary of Defense Thomas S. Gates last week cited the contribution former high ranking military officers employed by industrial firms are making to the national defense. He was opening witness before a House Armed Services Subcommittee investigating charges that weapons contracts are being let by influence instead of by merit.

With the qualification that "we would regard any improper use of influence or friendship as reprehensible," Gates told the subcommittee, headed by Rep. Edward Hebert (D.-La.):

"My principal purpose . . . is to emphasize equally our conviction that those retired officers who are now employed in private enterprise are making a significant and perhaps irreplaceable contribution to national defense and the industrial capacity of this country . . . An increasing number of fine officers with many years of expert experience in the operation of the Department of Defense are each year being retired from active duty . . .

"(Some) have found that the chief contribution which they can make is to private industry, and particularly that segment of private industry dealing with the matters with which those officers have achieved a professional competence. We see no reason why this form of employment of retired officers should be forbidden to them. We feel that any such course would work a grave injustice not only on the individual involved, but also on the industry, which may well find that the administrative skills and the high professional and technical ability of the retired officers cannot be duplicated at any price . . .

"We are discussing men like MacArthur, Doolittle, Bradley, Radford, Ridgway, Bedell Smith, and scores who could be named. . . . We are discussing also many fine young officers. . . . It is my firm conviction that our retired officers carry on into retirement the fine character which carried them successfully through their honorable careers. . . ."

At the opposite extreme, Rep. Alfred E. Santangelo (D.-N. Y.), author of the most drastic legislation on the subject—it would ban contracts to firms that employ former high ranking officers within five years after they leave the service—told the Hebert subcommittee that "this practice of hiring retired officials smells to the high heavens and races with missiles and aircraft to outer space." Santangelo went on to suggest "that Pentagon influence cannot be proven because procurement officers will not speak for fear of destroying their future advancement . . . that procurement officers await the day when they shall retire so that they can join defense contractors at lucrative salaries . . . that procurement officers are motivated by a desire to feather their future nests and thereby grant negotiated contracts when the items lend themselves to competitive bidding."

Santangelo has modified his proposal —which last month was passed by the House 131 to 130 but later was defeated 125 to 147 on the assurance of an investigation by the Hebert group which would pave the way for a more considered approach (AW June 15, p. 28). Universities and firms doing less than $1 million a year business with the Department of Defense would be exempted from the five-year ban on hiring ex-officers. Santangelo also suggested the establishment of a review board which could make exceptions.

Rep. Hebert observed that the subcommittee's task is to sift the wheat from the chaff, facts from unfounded allegations, to define "the problem area" and deal with that.

"The American people are alarmed and aroused at what they see and what they hear today about the conduct of our weapons procurement and about the alleged conduct of some military men who depart the ranks of defense for lush places on the payrolls of defense contractors," he declared. Hebert said the two key questions the subcommittee must determine are:

- **"What is 'selling'?** Is the man who signs the contract or who carries the 'order book' the one who 'makes the sale'? What constitutes negotiating for sale? Which one of the many persons working for a company manufacturing a weapon and offering for sale actually sways the decision?"
- **"What of the advertising** by defense contractors? And what of the images fashioned by the man in the gray flannel suit with new job descriptions and deceptive titles for what is actually being done? Who finances these programs? Who profits by them? Do the military or civilian officials of the military department encourage these pressures?" Gates conceded that there might be "some question of the public advertisements" of some defense contractors.

Gates reported that a partially completed survey by the Navy has disclosed 300 cases which might involve violations of present "conflict of interest" laws. These are now being investigated.

Other testimony included:

- **Rep. Samuel S. Stratton** (D.-N. Y.), who pointed out that his district includes two major defense contractors, General Electric Co. and Alco Products Co., urged the subcommittee not to go on the assumption that "there is something inherently wrong with a retired officer going to work for a defense contractor. . . ."
- **Rep. Charles Bennett** (D.-Fla.) asked favorable consideration of legislation he is sponsoring which would penalize firms for hiring former officers or civilian defense officials who have dealt with the firm within two years before retiring.
- **Sen. Paul Douglas** (D.-Ill.) and Sen. Jacob Javits (R.-N. Y.) urged their bill which would ban former officers from selling or negotiating with their former service for two years.

News Digest

Request for formal proposals on "Quick Globe," 473-L, new electronic data processing system which will display status of Air Force operating commands in USAF headquarters in Washington, D. C. (AW July 6, p. 23), is expected to go out to industry in about two weeks. Contractor selected must hold top secret facility clearance.

John F. Smith, public relations manager of Pratt & Whitney Aircraft Division of United Aircraft Corp., was promoted to assistant to William P. Gwinn, president of United Aircraft. Smith will be succeeded by Frank Murphy, assistant to the director of public relations for United Aircraft.

Soviets recovered two dogs and a rabbit in good condition from a single-stage geophysical ballistic medium-range rocket launched July 2. Payload exceeded two tons. Instruments yielded data on composition of light gases in the atmosphere "for the first time," according to Tass, Soviet news agency, and new data on the conduct of animals in state of weightlessness.

Sud Aviation and Agusta, of Italy, are jointly working up a flying crane project. Mission requirement laid down by a tripartite military group composed of representatives from France, Germany and Italy, calls for a payload of 8-12 tons.

Advanced version of Terrier surface-to-air missile has gone into production at Pomona, Calif., plant operated for U.S. Navy by Convair Division of General Dynamics Corp.

AIR TRANSPORT

Jets Spark Strong Recovery in Traffic

Steady expansion breaks industry loose from slump, with most airlines reporting all-time June highs.

By L. L. Doty

Washington—Airline industry, sparked by a spectacular recovery of traffic growth during the past six months, now appears headed for the most prosperous year in its history.

Traffic activity during June has broken all previous monthly records to climax a six-month period of steady expansion that brought last year's industry-wide depression to a halt. Individually, most carriers will report June traffic as having reached all-time records for the number of passengers carried in any one month.

Early estimates, drawn from an AVIATION WEEK survey of the trunkline industry, indicate that revenue passenger miles for June will top 2.7 billion, a 14% increase over June, 1958, and a substantial climb over the previous record of 2.38 billion set in August, 1958.

Northeast Airlines led the trunkline industry with an estimated 37% increase in revenue passenger miles in June, compared with the same month last year. Northwest Airlines, holding to the sharp traffic growth trend it has consistently recorded each month this year, will report an estimate 18.8% increase in revenue passenger miles for the same period.

Turboprop Factor

Northeast Airlines sales and traffic vice president, Nelson B. Frye, attributed the traffic increase to the use of the turboprop Vickers Viscounts in the high-density Boston-New York-Washington markets. The carrier has keyed its schedules in this area to the commercial travel market to offset seasonal declines in vacation travel. Nevertheless, Northeast showed a 25% increase in vacation "package" sales as of June 25 over the same period last year.

In the transcontinental market, American, Continental and Trans World airlines continued to reap benefits from the operation of the Boeing 707 turbojet fleets. All three carriers reported load factors on the turbojets in the "high 90's."

Continental carried more than 6,700 passengers between Los Angeles and Chicago during the first three weeks of 707 service—from June 8 through June 28. The carrier began the service with one round trip daily, increased the service to three round trips daily in the third week and now is carrying more than 4,000 passengers per week on the route.

American Airlines reported a system-wide load factor of 72.4% for the month of May. TWA trailed only slightly with a 70.3% load factor.

Closest contender to the two airlines was United Air Lines with a May load factor of 63.9%. Load factors of TWA and American for May topped figures set in May, 1958, by the two carriers by more than 10 points.

In the New York-Florida market, where the competitive scramble for business is beginning to take on more than a faint aspect of a rate war, load factors remained consistently low. With an industry average in May of 60%, Northeast reported 44.8%, National 51.2% and Eastern 48.5%. Delta's load factor for the month was 56.7%.

Some recovery in the load factor area will be reported for June with Northeast passing the 50 mark and National moving close to 55%. Eastern's traffic hit an all-time high in June with 849,800 passengers, a 10.9% increase over the previous June.

However, the airline is operating its peak fleet of 221 aircraft at a high utilization rate which may prevent its load factors from climbing much beyond the 1959 high of 56.8% set in March, a previous record month when 842,700 passengers were carried. In April, Eastern's load factor was 53%.

National also will report a spectacular increase in revenue passenger miles for June—probably as much as 20%. During the first three months of 1959, the carrier reported load factors ranging from 61 to 64%, well above those of its two direct competitors, due primarily to the service operated with the Boeing 707s leased from Pan American. In May, National's revenue passenger miles reached 78.9 million compared to 64.6 million earned in May of last year.

Resort business in the Miami area has not tapered off as sharply with the end of the winter season as it did last year. Hotels and resorts are reporting heavy traffic but new carriers in the market—Capital, Northwest and TWA—are experiencing traffic declines on their Florida routes which would indicate surface transportation is attracting a number of early summer vacationers.

Capital Airlines' business picked up notably in June after experiencing an approximate 30-day dip in traffic volume immediately following the Viscount crash near Baltimore (AW May 18, p. 41). For June, Capital will report 149 million revenue passenger miles, a 3.6% increase over the same month last year.

This increase was accomplished in the face of a 6% decrease in plane miles in the same period. The airline will report a 62% load factor for June, a substantial rise compared with the low 56.5% the carrier hit in May after topping 60% in April.

TWA Leads Gains

Of the Big Four operators, TWA will report the largest gains in traffic for the month of June. The total of 439 million revenue passenger miles the carrier will report for the month represents an increase of 18.9% over the previous June. Revenue passenger miles handled in June on the Boeing 707 flights alone will top 95.6 million.

During the three-day July 4th weekend, the airline generated 36 million revenue passenger miles—a 24% increase over the 1958 three-day weekend.

American will report a 14% increase in revenue passenger miles—from 550.7 million in June this year compared to 486 million in June of last year.

Buffeted on all sides by stiff jet competition, United Air Lines continued to hold a strong position in the transcontinental market. The carrier reported the largest volume of passenger traffic for any month in the company's 33-year history in June when it flew 534.6 million revenue passenger miles, an increase of 4% over the same month a year ago.

United, which plans to begin Douglas DC-8 turbojet service in September, has met the competitive impact of the turbojets by cautious scheduling of aircraft and the continued maintenance of a peak operating performance record. During May, the carrier flew 433 million revenue passenger miles while maintaining a record of 98.8% of all schedules completed. On-time performance for originating flights during the month was 74%.

That United is not competing against

Tu-114 Meets Britain's Heavyweight Turboprop at Idlewild

Tupolev Tu-114, world's biggest civil turboprop transport, makes a striking comparison with Aeronaves de Mexico Bristol Britannia 302, on the international arrival ramp at N. Y. International Airport. Behind the two turboprop transports, Pan American World Airways' umbrella-shaped passenger terminal is seen under construction. Aeroflot's heavyweight, which recently brought Frol Kozlov, Soviet first vice-chairman of the Council of Ministers, to New York nonstop from Moscow in 11 hr. 6 min. (AW July 6, p. 38), measures 167.28 ft. in span, 177.12 ft. in length, weighs just under 200 tons loaded. The Britannia—largest civil transport in scheduled operation—has span of 142.25 ft., length of 124.25 ft. and weighs approximately 82.5 tons. Tu-114's four Kusnetzov turboprop engines develop well over 12,000 shp. each compared with 4,120 shp. for Britannia's Bristol Proteus engines. Tu-114 seats 170-220 passengers, the Britannia up to 133. Flight crew of the Tu-114 is 10: two pilots, navigator, flight engineer, radio operator, two cooks and three stewardesses—Britannia has crew of nine. Russians say that the Tu-114 is more economical to operate than the Britannia, indicate they could begin nonstop passenger service to New York this year if permission is received from U. S.

the turbojets without feeling some traffic pinch, however, is indicated by coach and first-class traffic records. In May, coach traffic climbed a huge 20% over the previous May while first-class traffic toppled 8.5% in the same period. Load factor for May climbed 2.5 points, compared with a 3.86 point rise for the trunkline industry.

Western's Load Factor

Western Air Lines' load factor in May stood at 54.9%, compared with 57% in April and the year's high of 60.5% in March. Western flew 63.5 million revenue passenger miles in May. Since the carrier was grounded by a labor strike last year from Feb. 21 to June 1, comparative figures are not available.

Braniff reported a May load factor of 60.5% and revenue passenger miles of 183 million. Load factor is up in June and the carrier will report about a 6% increase in revenue passenger miles.

Gross revenues for the entire industry rose sharply in May. TWA's revenues jumped from $17.8 million in May, 1958, to $22.5 million for the same month this year.

Delta's gross revenues moved from $7.1 million in May, 1958, to $8.5 million in May of this year. Braniff and Capital showed slight rises: from $5 million to $5.5 million and from $8.8 million to $9 million respectively. Northwest revenues climbed from $5.2 million to $6.9 million for the comparative months of May.

Gross revenues for the 12 trunklines will show an approximate 16% increase in May over the previous May. Since the carriers have held their expense level to about an 11% rise in the same period, chances are strong that the profit picture will take on a healthy glow when final results for the first six months are compiled.

Supersonic Version Of Caravelle Studied

Paris—Sud Aviation is studying two new versions of its medium-range Caravelle jet transport: a "baby Caravelle" and a "super Caravelle" capable of supersonic flight.

The company says its baby Caravelle would carry 40 passengers, just half the number carried in the present Caravelle, and would operate over short stage lengths.

Sud gave no additional details on its long-range plans for the supersonic version. Disclosure of the Caravelle development plans were made in the company's annual report.

Besides these two versions, it is also known that Sud is planning to modify its present Caravelle airliner with the hope of attracting the military and executive transport market.

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Report on Japan Air Lines, Part I:

Japan Air Lines Aims at World-Wide Role

By Irving Stone

Tokyo—Japan Air Lines is preparing for a world-wide role in which its Douglas DC-8 jets, scheduled for delivery next year, will play a prime part. Also figuring prominently in the airline's future planning is the short-medium range jet transport and the vertical takeoff and landing (VTOL) type aircraft to meet economic competition in its domestic and Asian routes.

Japan Air Lines' jet operations will encompass three main categories:

- **Tokyo-U. S. West Coast runs.**
- **Polar route.**
- **Global route.**

Already, Japan Air Lines is spanning the Pacific from Tokyo into three West Coast ports—Los Angeles, San Francisco and Seattle. Complementing its San Francisco-Tokyo run, the airline inaugurated service from Los Angeles on May 30, from Seattle on June 29. Douglas DC-7-Cs are used on these runs.

First delivery to the airline of DC-8s —combination first-class and coach versions—is scheduled for May, 1960, followed by a second one in June. Depending on the speed of the training program, it is possible that Japan Air Line's DC-8 jet transport service may start earlier than July, 1960, the month now scheduled for partial changeover to jet operations across the Pacific between U. S. and Tokyo.

JAPAN AIR LINES Douglas DC-7C flies over Tokyo in the vicinity of Haneda Airport. The Tokyo television tower, similar to the Eiffel Tower in Paris, is tallest in the world.

DC-8 Schedule

First Japan Air Lines jet flights will be on the mid-Pacific run, simultaneously between Tokyo and San Francisco and Tokyo and Los Angeles, with Honolulu as an intermediate touchdown point. Initially, two jet flights each week are planned between San Francisco and Tokyo and Los Angeles and Tokyo to complement the DC-7C flights, which probably also will be two each week between these same points. This means that initially there will be a total of four jet flights and four DC-7C flights per week between U. S. and Tokyo. This compares now with three DC-7C flights per week between Los Angeles and Tokyo, and four flights between San Francisco and Tokyo, of which three are done with DC-7Cs and one with a DC-6B.

Third DC-8 is scheduled for delivery to Japan Air Lines in late July, 1960, for service in August, 1960, with the fourth to follow in the middle of October, 1960. Japan Air Lines has no option on additional DC-8s at this time.

With delivery of the third DC-8, the airline will inaugurate two nonstop jet flights per week between Seattle and Tokyo, eliminating the DC-7Cs from this JAL route.

Simultaneously, the airline also will increase its jet schedule between San Francisco and Tokyo to three flights per week, removing the DC-7Cs on this run.

At this point, Japan Air Lines traffic executives will review the over-all picture and if traffic demands justify it, the Los Angeles-Tokyo run may be boosted to three jet flights per week, with removal of the DC-7Cs on this run.

When the fourth DC-8 goes into operation in late October, 1960, Japan Air Lines plans to extend its transpacific jet operations to take in Hong Kong via Tokyo. Initial frequency would be two flights per week between these points, with possible increase in frequency if traffic warrants it.

Beginning in April, 1961, Japan Air Lines will start two jet flights per week between Tokyo and Copenhagen or London, via the North Pole, with Anchorage, Alaska, as the intermediate letdown point. This flight, Japan Air Lines officials declare, could be accomplished without any additions to its fleet of four DC-8s.

Beginning sometime in 1962, the airline plans to fly nonstop into New York from Seattle with its DC-8 for two flights per week. This route is not included in the present bilateral agreement between Japan and the United States, hence would require negotiation between the two countries. If this run were initiated, additional DC-8s would be required, but feeling in the airline is that this equipment could be obtained sufficiently fast if the route were opened.

The New York run would give Japan Air Lines a global network—Tokyo-Seattle-New York-London (or Copenhagen)-Tokyo; or progressing another way, from London to Paris-Rome-Beirut-Karachi-Calcutta-Bangkok-Hong Kong-Tokyo.

If permission for the run from Seattle to New York is not granted by the U. S., the airline's global network plan would be defeated. Approximately 25% of JAL's transpacific passengers now go on to New York or originate in New York. The airline's opinion is that there is

Relief globe by Panoramic Studios

In a record-breaking flight from Seattle to Rome — 5,830 miles, nonstop — the Boeing 707 Intercontinental demonstrated its prowess as the world's newest, longest-range jetliner. On its return flight, the 707 Intercontinental left London at 3:18 P.M. London time, arrived in Seattle at 3:56 P.M. Seattle time the same afternoon. This great, new Boeing jetliner goes into commercial service later this year, bringing unprecedented range, speed and comfort advantages to the airline routes of the world.

These airlines have ordered 707 and shorter-range 720 jetliners (asterisks indicate Intercontinental purchasers):
*AIR FRANCE • *AIR INDIA • AMERICAN • *B.O.A.C. • BRANIFF • CONTINENTAL • CUBANA • IRISH • *LUFTHANSA
*PAN AMERICAN • QANTAS • *SABENA • *SOUTH AFRICAN • TWA • UNITED • *VARIG • *Also* MATS.

BOEING 707 Intercontinental

sufficient traffic for both American carriers and the Japanese carrier.

Beyond the broad picture of JAL's DC-8 operation, the airline is studying the possibility of using the projected Douglas DC-9 for covering short-medium range operations, for example, between Tokyo and Southeast Asia (Hong Kong, Singapore, Bangkok, Jakarta, Manila, Taipei) and also to Europe by way of India.

Japan Air Lines probably will want a combined first class-coach arrangement with a range of approximately 2,000 mi., which would be covered by the DC-9 specifications Douglas has issued (AW June 29, p. 30).

Probability is that Japan Air Lines might order five short-medium range turbojets initially. It would like to have these transports in operation sometime in 1961. If this tentative timetable holds true, it would eliminate the DC-9, which isn't scheduled for service before 1963, if it is built.

In connection with its Tokyo-Singapore run, via Hong Kong and Bangkok, JAL now is feeling the impact of British Overseas Airways Corp.'s Comet 4 operations which started last April. The airline attributes acceptance of BOAC's jet service to the faster and more comfortable flight at the same fare.

Competition in this area is not from BOAC alone, but also from Cathay Pacific, which operates Lockheed Electra turboprops between Hong Kong and Calcutta (which takes in the JAL route between Hong Kong and Singapore). Also, since July 1, Cathay Pacific has included Electra turboprops in its Tokyo-Hong Kong run.

Short-Medium Range Jets

Because of this competition, it is likely that Japan Air Lines will make a special effort to introduce the short-medium range jet into Western Pacific regional service. It is studying application of the Comet 4, and even possible use of the Boeing 720 and Convair 880 turbojets, with a possible 1961 operational target date. If the Douglas DC-9 is built and its performance is economically feasible for operation on short-range runs in Japan, there is a possibility that it may be ordered as a follow-on aircraft, JAL officials say.

The airline is not leaning toward use of turboprops, because its reasoning is that when short-medium range jets go into service, the turboprop would not be competitive as to speed, an opinion not shared by many other carriers.

Introduction of VTOL-type aircraft is getting serious consideration from JAL planners. Probably no other country has had its air transportation challenged so severely by railroad transportation, as in Japan. This type of transportation is very efficient, fast, relatively inexpensive and offers great attraction to the traveling public which, because of Japanese income levels, must economize.

Comparative figures for railway and air travel are illustrated by the National Railway run between Tokyo and Osaka (350 mi.), which takes 6 hr., costs about 4,500 yen ($12.55). The writer can attest to the excellence of this railway service, which probably is comparable to anything in the United States.

By air, the Tokyo-Osaka trip takes 1¼ hr., costs 6,300 yen ($17.56) in a DC-4 five-abreast configuration, plus another hour for terminal-to-city ground transportation at each end, bringing the time for the total trip up to 3¼ hr.

Nevertheless, the load factor on the Tokyo-Osaka run is approximately 71%, indicating acceptance of air travel.

Future Rail Competition

But Japan Air Line's new concern is that the National Railway has started construction work on a new trunkline service linking Tokyo and Osaka with only 3-hr. travel time—¾ hr. less than it now takes by air, including terminal-to-city transportation. Service is to be inaugurated in 1964.

Actually, before the new railroad project was undertaken, there was considerable discussion between the government and JAL. The government's decision to go ahead with the new trunkline in effect meant that it was competing with itself, since the government owns 75% of the airline, with the other 25% commercially owned by banks, insurance companies, private railroad and steamship companies, and a small percentage of private stockholders. However, the great volume of freight (raw materials) moved by the railroad was probably a decisive factor in the government's decision.

To meet the challenge of the railroads, Japan Air Lines is considering the possibility of lowering fares for domestic air service. Secondly, it has created a special committee to study the feasibility of introducing VTOL aircraft for use between Tokyo and Osaka. The study comprises both technical and financial aspects and is comparing such equipment as the Sikorsky S-61, Vertol 107, and Fairey Rotodyne, for city-center to city-center service.

Present traffic picture in the transpacific runs does not necessarily represent a ge[illegible] similar si[illegible]n when the jet [illegible]s are phased in. Japan Air Lines officials see ec[illegible]ic probl[illegible] ahead [illegible]t of [illegible] jet transport's vastly increased capacity.

On the run between Tokyo and Honolulu, both eastbound and westbound, Japan Air Lines has had a load factor of approximately 99% with respect to first class and tourist passengers and cargo.

Before the airline inaugurated service at Los Angeles and Seattle, its transpacific eastern terminal was San Francisco. Los Angeles-bound passengers took other carriers (Pan American World Airways and United Air Lines) from Honolulu. A similar situation applied to passengers in the U. S. going to Japan from Los Angeles. Actually, 70% of the JAL through-passengers moving between Tokyo and San Francisco stayed over at Honolulu for some days. All this naturally cut load factor to 74% between Japan and the West Coast.

The Tokyo-Seattle great circle route, which the airline began operating June 29, probably will be used more by commercial passengers who want fast transportation between Tokyo and New York. The load factor over this northern Pacific route is not expected to be as favorable as the central Pacific route. If Japan Air Lines can yield a load factor of 80% in the first six-month period, it would be well satisfied. Actual figure is expected to run as high as 70%, but as the advantage of using this shortest route between Japan and U. S. is realized, JAL expects the load factor to become comparable with that of its central Pacific run. But, while the northern Pacific route is nearly 2,000 mi. shorter than the central-Pacific route, the same fare applies to both runs, and JAL actually can put up with even lower load factors over this great circle route than it enjoys over the mid-Pacific run, with comparable economic results.

Challenge to All

All transpacific carriers will meet a new challenge with the inauguration of jet flights, the airline's officials feel. Notwithstanding the high load factors all operators now enjoy, increase of capacity and frequency introduced by the bigger and faster jet transports will put carriers in the position of having more over-all capacity than the actual traffic will demand, JAL believes. The solution will have to come from industry in terms of increased travel between the U. S. and Japan, based primarily on the much shorter time involved, JAL feels.

Airlines also may have to think of a new type of economy-class service with these transpacific jets, bringing fares even below present coach charges, JAL traffic planners believe, so that airlines can exploit new passenger potentials. This new type of service would be comparable to economy-class service in existence on North Atlantic runs.

(This is the first of two articles on Japan Air Lines' plans for jet-age expansion. The second article will appear in next week's issue.)

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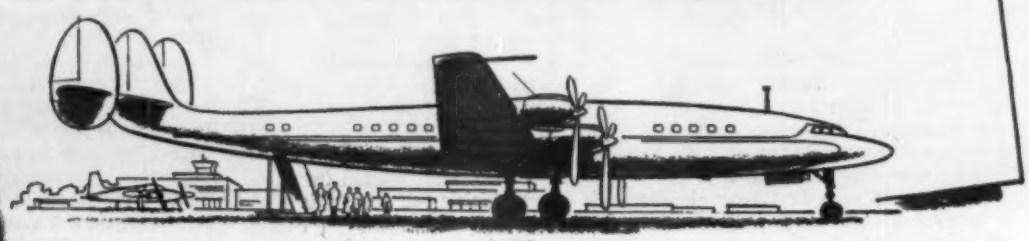

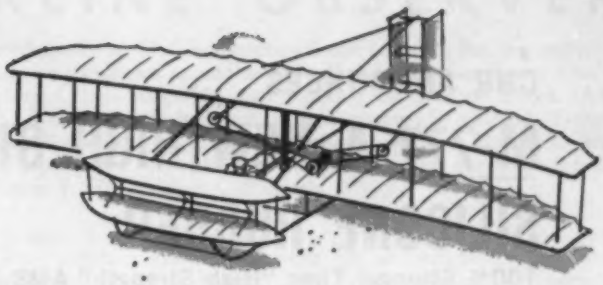

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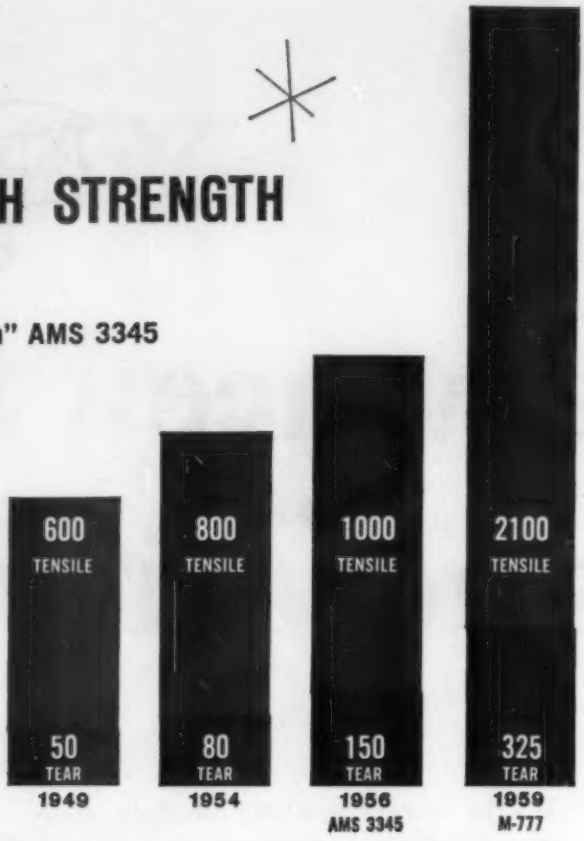

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AMS-3345	Durometer Shore A 50 ± 5 Tensile Strength, psi 1000 Elongation % 500 Tear Strength, lbs./in. 150	Durometer Change 0 to + 20 Tensile Change - 50 Elongation Change - 40	73	−105°F

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SHORTLINES

► **Air France** will conduct a 29-day tour of Europe's leading fashion centers starting in early October. Cities included in the tour are London, Paris, Rome and Madrid, with visits to the leading dressmakers in those cities and talks with magazine editors in New York, London and Paris.

► **Alitalia** will begin operating 10 daily round-trip flights between Naples and Capri and Naples and Ischia in the Bay of Naples using four Sikorsky S-58 helicopters. Operating under the name of Elivie, the line will make the trip in about 20 min. compared to about 1¼ hr. by boat to the two islands. Alitalia reports it carried 3,904 passengers from New York to Europe in June, compared with 1,951 passengers flown in June, 1958. The carrier's six-month passenger total for 1959 stands at 11,156, or 130% above the same 1958 period.

► **Allegheny Airlines** carried 56,934 passengers during June for a new company record and a record 5% load factor for the month. Air express and air freight increased 34% over June, 1958, to 614,802 lb.

► **Eastern Air Lines** is installing a snow melting system using superheated water at its New York International Airport terminal, now under construction. In all, about 76,000 sq. ft. or 1¾ acres will be kept clear of snow in the winter.

► **Flying Tiger Line** reports it reached a 100% on-time departure record during June, on its transpacific routes. The line operates from Travis AFB, Calif., to Tokyo and return via Wake Island and Honolulu, for the Military Air Transport Service.

► **Military Air Transport Service** has awarded a $4,390,614.99 contract to operate an airlift in logistic support of the U. S. Navy to United States Overseas Airlines of Wildwood, N. J.

► **North Central Airlines** carried 93,569 passengers during June, a 32% increase over June last year. The carrier reported it flew 99.6% of its scheduled miles with its fleet of four Convair 340 and 32 Douglas DC-3 aircraft.

► **National Airlines** board of directors has declared a year-end extra cash dividend of 12½ cents per share on its outstanding common stock, payable July 30, 1959, to stockholders of record July 16, 1959. The board also declared a 2% quarterly stock dividend, payable July 30, 1959, to holders of common stock of record July 16, 1959.

AIRLINE OBSERVER

► **Anticipated shuffle of Civil Aeronautics Board members has not materialized and the long expected appointment of Board Chairman James Durfee to a Court of Claims judgeship, first reported by Aviation Week (AW Mar. 16, p. 25), apparently has been at least temporarily shelved. Feeling is strong that there will be no rush about replacing Member Harmar Denny, whose term expires Dec. 31, until later this year. Leading candidate for the post is Vernon T. Hitchcock, a Californian.**

► Railroads have launched a campaign urging adoption of the "one package" transportation system—the principle of one carrier providing several modes of transportation under a single management. Program is directed against laws and restrictions which prohibit a common carrier from operating types of transportation other than that for which it is certificated.

► **United Air Lines and Trans World Airlines common stock prices continue to work steadily upward toward new highs for the year. Listings of other domestic trunklines show strength but fall short of year's highs by averages of two to six points.**

► Recent Civil Aeronautics Board accident investigation findings listing pilot error as probable cause have drawn strong protest from Member Louis J. Hector who feels the Board may be overstepping its authority to render a factual, instead of a responsibility, finding. In a five page dissent against his colleagues, who last week placed the blame for the crash of a Capital Airlines Douglas DC-3 training flight last year on failure of the instructor pilot to regain control of the aircraft after a trainee lost control during an attempted go-around, Hector said the Board should confine itself to an accurate description of the sequence of events that a statement of the mistake of judgment responsible for the accident while leaving questions of responsibility and liability to the pilot certificate procedures of the Federal Aviation Agency.

► **British government is showing increasing impatience over White House foot-dragging on a final decision in the British Overseas Airways Corp. move to serve Tokyo (AW June 1, p. 25). Case is now waiting President Eisenhower's signature following a Civil Aeronautics Board decision to back the BOAC request. Recently, the Earl of Gosford told the House of Lords that "Her Majesty's government have left the U. S. authorities in no doubt about their great dissatisfaction with the continued delay in the grant of this permit . . ."**

► Trans World Airlines pilots and flight engineers are taking instructions on Convair 880 turbojet systems and cockpit procedures at the manufacturer's San Diego base. Training will be followed in November with a three-week ground course and transition training of TWA's flight acceptance crews.

► **Federal Aviation Agency has proposed a regulation which would impose a fine of $1,000 on any passenger who consumes liquor aloft on a scheduled flight if it has not been served to him by the carrier. In addition, the airline will be subject to a similar fine if a passenger who appears intoxicated is served liquor by the carrier.**

► Report by a British parliamentary committee has warned that international airlines will suffer severe financial losses if "feverish and unrealistic" competition in new equipment is emphasized. The Select Committee on Nationalized Industry, which began a study of British Overseas Airways Corp. and British European Airways last May, quotes British European Airways Chairman Lord Douglas of Kirtleside as saying, "The whole of the airline industry has gone a little crazy about jets."

► **International Air Transport Assn. has banned in-flight operation of portable radios by passengers because of interference to indicator instruments of radio navigation aids.**

TRAINING center at Kansas City is run by TWA like an aviation college. First jet simulator (left), for Boeing 707-120, gets 14 hr. of utilization daily. Training aids include panels like one at right detailing 707's a.c.-d.c. electrical systems.

Advance Planning Cuts TWA Jet Delays

By Glenn Garrison

Kansas City—Trans World Airlines cites a comprehensive jet planning program as responsible for the smoothness of its Boeing 707-130 operation, which the airline reports has encountered a minimum of delays and maintenance problems.

From the first schedule Mar. 20 through June 20, TWA's record was 77.1% of all jet departures on time or not more than 10 min. late. Of the rest, 12.5% departed less than 30 min. late, 3.7% less than an hour, and 6.7% more than an hour. There was only one cancellation.

Basic Techniques

As a result of the long-range planning, TWA entered its jet era with some basic techniques it feels have contributed to satisfactory integration of jets. Among them:

- **New maintenance philosophy** involving specialization at major terminals and at the overhaul center in Kansas City, with close communication and coordination between the center and the line stations.
- **Establishment of a flight** operations training program of considerably greater comprehensiveness and strictness than in the past. Ground school and simulator training is carried out a $7 million flight training center in Kansas City, opened about two years ago.
- **Ample parts provisioning** for the airplane, with orders placed well in advance and deliveries scheduled over a period of time. By buying some parts in quantity before the production airplanes were built, TWA says it saved 25% in unit costs.

The airline's new maintenance system is essentially a concept of specialization plus day-to-day auditing of each flight. Technical specialty foremen were appointed at major maintenance bases and assigned the local responsibility for their systems, such as powerplants, fuel tanks and structure, electronic, hydraulic, and the like. The 12 major maintenance stations are tied in by private telephone line with a maintenance coordinator in the Kansas City base. Regular daily conferences are held over the telephone system and any malfunctions are reported and discussed. Where necessary, the central coordinator can bring in top specialists in the Kansas City service engineering center to advise the local specialists or to follow up with the manufacturer.

An example of how this close day-to-day communication can prevent delay is provided by a recent eastbound transcontinental jet schedule. An irregularity was found in the 707's fuel heater exhaust port, supposed to dump hot gas overboard. The port was not long enough to clear the cowling and the exhaust was spilling inside the cowling. The pilot was reluctant to take off from Los Angeles until the trouble was corrected, but a conference with Kansas City brought out the fact that this irregularity was understood, was harmless, and a modification was in the works. The jet departed on time, whereas hours might have been lost if the local specialist had not been able to get the latest from the maintenance coordinator.

TWA actually began introducing its new maintenance concept with the Lockheed 1649A Starliner, believing the complexity of its Turbo Compound engine, new autopilot and other units called for a new approach. Previously the Kansas City engineering base had been essentially a modification center, dealing more with the long-range aspects of maintenance problems than with the day-to-day function.

The center would get reports of maintenance problems from line stations after about six weeks. Setting up the basic service engineering system, with the trained system specialists at the local level, cut this lag to about 24 hr., and replacement of teletype reporting by the telephone hookup completed the transition.

Telephone Conferences

Under the present system, the telephone conferences are held at least four times daily whether trouble has developed or not. There is an audit of every flight log at the center with a running check on fuel use, engine performance and the like. If these audits indicate, for example, poor fuel consumption, the center can advise all stations to check all fuel injection nozzles for leaks. On the basis of data from the line experts, the center can go to the engine manufacturer for a fix.

Operating procedures are also part of this regular audit. TWA, incidentally, has oriented its jet operation to the pilot in many respects. One example is a simplified manual which gives pilots a great deal more route planning flexibility. Curves in the official charts have been reduced to numerical tables for quick reference, and a pilot can select a flight plan quickly to fit available altitudes. This manual has been copyrighted.

The service engineering center is now

under the supervision of TWA's Technical Services Division. Under recent reorganization moves, the airline's functions are broken into three areas of responsibility: transportion, under a vice president charged with producing the product—i.e., operating and scheduling the aircraft; sales, to market the seats; and technical services, whose job includes maintenance of the Trans World Airlines' fleet.

Flight operations training comes under the transportation division's jurisdiction and its training center, established in a renovated building in downtown Kansas City, is designed to resemble a full-fledged aviation college.

Floyd D. Hall, new vice president-transportation, told Aviation Week that the training center has a much stiffer curriculum and is run along considerably more formal lines than the usual airline training classroom. Planning for the training courses began more than three years ago and was based partly on an analysis of military jet experience.

Jet captains spend four weeks in the school, including 60 hr. of familiarization courses and at least 10 hr. of simulator training. The captains, as well as first officers and flight engineers, take a four hour, closed book final examination before moving into the transition flight training program and then to line qualification training.

Transition Training

Captains' transition training was originally planned at 14 hr., Hall said, but for a while it was running between 20-25 hr. Factors causing trouble in this program, according to Hall, included apprehension among the older pilots "as to whether they could fly this monster with the glow pipe in the back." Another factor was the inclusion of flight maneuvers which later were deemed unnecessary to pilot training, being actually more pertinent to certification of the airplane itself. With a more relaxed attitude on the part of the pilots now, and elimination of these maneuvers, transition time is down around 10-15 hr. One captain checked out of transition training in 8 hr. Federal Aviation Agency rating rides took about 4½ hr. at first, as opposed to the usual 1½-2 hr., Hall said, but these check rides also are shorter, about 2-3 hr. now on the average.

Planning for Boeing 707-331 training is also under way now, Hall said. Pilots selected for service on the big Boeings are being given 707-131 assignments right away to prepare them for the 331. TWA wants these pilots to have a couple of months' experience on the smaller jet before flying the bigger one.

The specialization concept carries over into the school as well as the technical services. Instead of assigning one instructor to several courses, each teacher now specializes in one subject and the classes move from room to room. TWA goes in heavily for visual aids such as movies and panel layouts of systems.

A Boeing 707-120 simulator that cost about $1 million is now in operation at the center, a Convair 880 simulator is expected later this year, and a third jet simulator—possibly the 707-320—will be installed in the future.

Other equipment includes a $¼ million Link Visual System, with a television camera moving along a terrain and runway mockup and projecting the picture on a screen in front of the simulator cockpit. This unit will be in operation shortly.

TWA has had only two jet delays for lack of spare parts, and one of those —for a gear snubber—could not have been anticipated, in the airline's view. Despite TWA's poor financial situation when the time came to provision for the jets, the airline went ahead with a liberal approach to ordering parts and feels this has paid off handsomely.

Parts ordering in quantity began in late 1957, according to James A. Shaunty, director of technical purchasing. This was before the first production models had rolled off the line and meant that Boeing could order the parts from subcontractors in greater quantities because of TWA's order, thus effecting a saving all down the line. The TWA order called for parts to be delivered over a period of time as the jet operation expanded to various stations. The alternative would have been to order parts as needed with the activation of new stations. But this meant that if the supply of a part ran out sooner than expected, a lag would ensue while waiting for a re-order. Under TWA's arrangement, this emergency would be met by moving up the schedule of a part already on order and re-ordering for the later need.

Shaunty points out that provisioning for an airline involves many unknown factors and has historically been a "seat of the pants" operation. But TWA has been doing a good deal of work in applying operations research techniques to provisioning.

Availability of computers has made such techniques practical, in Shaunty's view. For example, TWA ran 86 million calculations about a year ago on a Univac in attempting to work out tables showing whether a part should be at a given station or not, based on how many landings are made before the part is needed. A basic aim of such experiments is to compare the cost of stocking a part with the cost of not having it when needed.

For example, keeping a certain part at Chicago that might normally be used once a year would cost $120 for the part, $6 to store it, and $7.20 for interest on the money tied up in the part. But one delay for lack of the part might cost $6,000 in revenue.

Four 880s Are in Final Assembly

Convair 880 turbojet transport in foreground—No. 7—will be the first of 10 delivered to Delta Air Lines. Delivery is scheduled for January. Aircraft behind it are Nos. 6 and 5 which will be delivered to Trans World Airlines in December and November, respectively. The 880 in background—No. 4—will be the first with a completed interior and will begin accelerated service testing in Convair's flight test program in August.

Comet 4B Makes First Flight

First flight of the de Havilland Comet 4B turbojet transport from Hatfield, England, lasted 3 hr. 40 min. This is the first of six Comet 4Bs being constructed for British European Airways. Aircraft is longer than Comet 4 but has shorter wing span. **(See p. 52.)**

American to Retrofit Turbofans on 707s

New York—American Airlines will convert all turbojet engines in its fleet of Boeing 707-120s and 720s to Pratt & Whitney JT3D-1 turbofan engines.

The turbofans will be retrofitted on 35 aircraft—25 of them 120s and 10 720s. The remaining 15 720s will be delivered with turbofan engines.

American also has ordered 25 Convair 600 jets with General Electric turbofan engines. The new modification program is expected to provide the airline with an all-turbofan jet fleet in 1962.

The fleet modification program will cost American about $13.4 million, according to the airline's estimate. The figure is based on a cost of $390,000 for converting each 120 airplane and $360,000 for each 720 airplane. The airline will perform the engine modification work itself at its Tulsa base.

Airframe modification will involve additional costs, but American is still discussing this program with Boeing and has no figures yet. According to Pratt & Whitney, the airframe rework will be necessitated by an increase in the diameter of the front section of the engines by 10-11 in., which means installation of new cowlings, bigger and heavier pods, and an accompanying strengthening of the aircraft structure in this area. The airframe modification will be done by Boeing.

By the engine manufacturer's figures, its JT3D-1 turbofans will produce 17,000 lb. of thrust initially and follow-on engines will be rated at 18,000 lb. This compares with 12,000 lb. of thrust for the JT3C-7 engines which will power the first Boeing 720s. Both the JT3C-7 and the turbofan are dry engines, whereas the JT3C-6 engine which powers the 707-120s now in service is rated at 13,000 lb. with water injection.

Pratt & Whitney says the new engine will provide about 50% more takeoff thrust and 20% more cruise thrust than the present engines. Its specific fuel consumption will be 12-15% less during cruise and 8-10% less during takeoff, according to Pratt & Whitney. The company also predicts a speed increase of about 30 kt. on the average with the turbofan, assuming no speed loss because of the airframe changes. Furthermore, the 707s will be able to climb immediately to cruise altitude on a transcontinental hop instead of step climbing as is done with present power.

Cruise thrust, according to Pratt & Whitney, will be more than 4,000 lb. at 475 kt. at 35,000 ft., compared with about 3,000 lb. for the JT3C-7.

Other advantages American expects will accrue from its turbofan program are an alleviation of the takeoff noise problem because of the quieter engines, economies from a single engine model instead of two in its Boeing fleet, shorter runway capability, range and payload increases.

A comparison by the airline of runway lengths needed by the 707-120 with each type of engine shows a 10,200 ft. takeoff requirement on a standard day for the airplane of 247,000 lb. gross with the straight turbojet engine, and 8,450 ft. for the plane at 257,000 lb. gross with the turbofan engine. The 720 at 217,000 lb. would need 8,500 ft. with the turbojet engine, and at 222,000 lb. would need 6,500 ft. with the turbofan.

American said no additional financing will be required to pay for the engine modification program. The airline's outside jet financing program has made $205 million available over-all, including $70 million raised earlier this year through sale of convertible debentures in a private placement.

The modification program will not affect the airline's engine leasing arrangements with Pratt & Whitney, General Electric, and Allison. Under these agreements, American leases the engines powering its Boeing 720s, Convair 600s and Lockheed Electra turboprops. It has bought the engines for the larger Boeings. Overhaul of the Allison engines in the Electras is done by the manufacturer, and all other engines are overhauled by American.

The conversion program is scheduled to begin next year as the turbofan engines become available. Because of its economy, the program is expected to pay for itself within a few years.

American now has 16 of its 707-120s in service and expects delivery of the final nine by the end of October. The 25 Boeing 720s are scheduled for 1960-61 delivery, and the Convair 600s for 1961-62 delivery.

Tupolev, Russian Delegation Visit Convair, Lockheed, Douglas Plants

By Richard Sweeney

Los Angeles—United States airplane designers should be able to tour Soviet Russian airliner production plants as he and his party were shown through Convair, Lockheed and Douglas facilities, Andrei Tupolev, leading Russian aircraft designer and a deputy of the Supreme Soviet of the USSR, said here last week.

Tupolev, touring the three plants at the official invitation of the U.S., said the Russians never are in anybody's debt, in referring to the kind of tour and hospitality U.S. designer could expect from their USSR counterparts.

The Russian delegation, in addition to Tupolev, included Alexander Arkhangelski, assistant chief aircraft constructor (second in command of the Tupolev design bureau); Sergei Yeger, assistant to aircraft general constructor; Mikhail Kouzmin, aeronautical engineer; Mikhail Nyukhtokov, a pilot; Julia Tupolev, the designer's daughter, and Maj. Gen. Mikhail Kostiuk, air attache, Soviet embassy, Washington.

After their arrival in New York on the 330,000 lb. turboprop Tu-114 transport after a non-stop flight from Moscow (AW July 6, p. 38), the USSR aviation delegation was flown to San Diego in a USAF Boeing VC-137.

At the Convair San Diego plant, Tupolev's party saw the Convair 880 jet transport production line, plus parts of the production line of the USAF F-106 interceptor which will enter squadron service next October.

Following the San Diego tour, the Russians were guests at a dinner in Los Angeles sponsored jointly by Lockheed and Douglas.

The Russians were taken through Lockheed's Electra production line and on a short flight in the turboprop transport. On landing, when the Lockheed pilot announced he would demonstrate a wave-off landing go-around, Tupolev declined in favor of a landing.

The Soviet pilot Nyukhtokov was in the Electra cockpit throughout the flight, closely observing the airplane's performance. With him was Gen. Kostiuk, himself a pilot who has flown Russian jet aircraft including multi-jet bombers and MiG fighters.

During the flight, both the Tu-114 pilot and Soviet air attache said they were favorably impressed with the Electra's handling characteristics.

The next day the group visited the Douglas company. In the morning they took an unclassified tour of part of the Thor IRBM production line, during which they saw the Rocketdyne engines as they are installed on the aft section of the airframe, including the gimbaling struts, and were able to get a look at the rocket engine's gas generator and turbopump assemblies. After an introductory talk by Elmer Wheaton, chief of Douglas' Missiles and Space Division, including a lecture on a cutaway model of the Thor missile itself, the Soviets saw a Douglas film on the first lunar probes, "The Big Reach."

Formal Statement

In making a formal press statement following the tours, Tupolev said the Convair 880 made the best impression on him, both in appearance (design), as well as its production line. He said he had not expected to find the airplane in serial production, i. e., airplanes in continuous production. Rather, he expected to see one or two or three prototypes being tested before production.

Concerning the Lockheed Electra, the Soviet designer said this turboprop aircraft has made a good impression on him, as well as its production line. He added "we think (that) not only on U.S. domestic routes but on foreign routes as well, the airplane will justify itself."

Tupolev said the production methods used in the DC-8 construction were very interesting (during the tour he expressed deep interest in Huck bolts, indicating he was unfamiliar with this type of fastening). Organization of the Douglas jet transport production line impressed the Russians favorably, Tupolev said. The Russian designer went on to say that "only a company the size of Douglas can build such an airplane without a prototype. They have saved much time. At all companies, the Russians showed considerable interest in the detail design of such things as electrical wiring system components such as plastic wiring ducts, also in the soundproofing used and its methods of attachment.

Tupolev said there is no nuclear powered aircraft flying in the USSR at present, without indicating whether this meant that a testbed with a combination of conventional and nuclear power was or was not now flying, or even whether or not a testbed similar in theory to the USAF Convair B-36H was in use in research on nuclear aircraft power.

Asked about his feelings concerning nuclear power for commercial airliners, Tupolev said there remains much work yet to be done, adding that no one had yet ascertained one important fact—how passengers would feel about riding in a nuclear powered airplane.

CAB Cites Sensory Illusion, Pilot Vigilance Lack in Northwest Crash

Washington—Pilot sensory illusion, combined with failure to maintain full vigilance over instruments during a takeoff, were cited last week by the Civil Aeronautics Board as probable cause of a Northwest Airlines Douglas DC-6B crash last Aug. 28 at Minneapolis, Minn. Although the aircraft was destroyed by fire, no fatalities were experienced among the 62 persons aboard, CAB investigators noted.

In other accidents, Board members determined that a false fire warning during climb-out, and the immediate feathering of a propeller, caused an emergency gear-up landing of a Frontier Airlines' Douglas DC-3C, last Aug. 23, near Pueblo, Colo. Failure of a Capital Airlines instructor-pilot to regain control of a DC-3C after control was lost by a pilot-trainee during an attempted go-around, was held by the Board as the probable cause of the crash of the aircraft on June 4, 1958, near Martinsburg, W. Va. One of the trainees aboard the Capital aircraft died the following day of severe burns, the Board said.

Reviewing the Northwest accident, CAB said the aircraft took off normally, climbed to an altitude of about 100 ft., then gradually nosed over and entered a descent which continued until it struck the ground. While sky conditions were clear, visibility varied between one-half to three miles because of ground fog and takeoff was made away from a lighted, built-up section towards an unlighted, open area, the Board pointed out.

Capt. James Wilkinson, the pilot, testified that the aircraft was operating normally during takeoff although his outside vision was obscured by the reflection of his landing lights against clouds or fog. He said he looked back into the cockpit, noted that his instruments appeared normal and registered a slight climb. Landing lights then were turned off as the flight engineer prepared to reduce engine power, when the copilot saw a fence ahead and shouted "pull it up." The plane struck the ground almost immediately and skidded about 1,600 ft. beyond the point of impact, the Board said.

Airline Traffic—May, 1959

	Revenue Passengers	Revenue Passenger Miles (000)	Load Factor %	U. S. Mail	Express	Freight	Total Revenue Ton-Miles	% Revenue to Available Ton-Miles
DOMESTIC TRUNK								
American	659,308	463,829	72.4	1,822,882	783,624	8,050,296	55,199,227	61.2
Braniff	183,196	79,835	60.5	330,765	192,456	729,926	8,921,062	50.7
Capital	327,321	134,159	56.5	502,623	264,434	390,236	14,016,464	50.2
Continental	85,117	41,556	53.6	116,291	41,880	184,389	4,331,809	48.4
Delta	261,336	127,191	56.7	415,779	292,607	1,235,935	14,169,371	51.7
Eastern	699,574	360,128	48.53	1,019,802	504,563	1,421,054	37,633,237	39.88
National	133,161	78,913	51.2	284,173	71,079	603,080	8,587,908	42.3
Northeast	100,651	39,982	44.8	80,253	36,040	129,078	4,072,479	36.4
Northwest	149,577	111,953	51.2	568,694	256,967	1,271,592	12,846,968	44.9
Trans World	438,650	377,289	70.3	1,192,139	633,321	2,490,915	40,499,657	60.3
United	601,441	415,525	63.9	2,834,309	1,033,296	6,371,335	50,107,128	57.9
Western	120,987	63,530	54.9	276,682	82,870	390,058	6,833,724	48.3
INTERNATIONAL								
American	8,293	7,850	50.6	9,032	346	261,746	1,083,268	57.6
Braniff	3,992	7,781	50.2	19,467	.....	104,070	976,986	46.5
Caribbean-Atlantic	23,195	1,583	63.9	2,176	.....	4,952	173,563	66.7
Delta	4,552	5,748	51.8	7,206	.....	44,462	690,491	45.9
Eastern	32,687	47,143	47.77	88,451	.....	33,627	5,074,868	43.30
Mackey*	.....	.....	.....	.....	.....	.....	.....	.....
National	5,909	4,448	49.4	9,001	4,416	41,907	526,327	43.8
Northwest	14,374	31,567	57.7	1,211,487	20,794	981,379	5,572,325	63.1
Pan American								
Alaska	4,416	4,368	48.5	27,691	.....	180,185	681,099	53.9
Atlantic	122,761	162,132	70.9	1,500,546	.....	2,617,603	21,081,907	63.7
Latin America	97,047	107,765	62.2	442,460	.....	4,435,787	15,384,827	62.9
Pacific	26,440	107,622	77.9	1,425,145	.....	2,247,023	14,986,751	72.4
Panagra	10,261	14,069	54.7	66,216	.....	487,298	2,091,702	58.7
Resort	.....	.....	.....	.....	.....	4,589,574	4,589,574	80.6
Trans Caribbean	6,378	10,350	76.0	.....	.....	179,153	1,015,673	72.3
Trans World	33,724	102,611	72.5	769,751	.....	1,973,696	13,329,010	69.8
UMCA	172	56	33.1	.....	.....	788	6,942	37.3
United	9,553	23,894	75.8	153,309	.....	114,481	2,706,153	73.9
Western	3,405	5,303	51.5	14,322	.....	15,055	592,137	53.9
LOCAL SERVICE								
Allegheny	47,672	8,258	47.1	11,933	21,262	27,576	848,987	46.9
Bonanza	19,127	4,610	42.4	5,947	2,220	8,526	460,787	49.7
Central	15,631	2,978	39.9	7,713	3,772	14,563	311,332	36.5
Frontier	24,217	6,042	39.1	22,265	10,875	81,055	695,906	47.2
Lake Central	20,250	3,300	45.1	4,111	18,842	.....	338,677	48.7
Mohawk	50,670	9,788	54.7	8,893	16,039	15,598	974,294	54.8
North Central*	.....	.....	.....	.....	.....	.....	.....	.....
Ozark	50,021	8,652	44.7	13,055	24,367	23,871	887,521	46.5
Pacific	38,753	8,676	56.0	14,818	4,594	8,488	855,341	54.6
Piedmont	43,873	9,384	47.2	17,533	14,090	18,145	948,829	47.6
Southern	22,827	4,050	39.2	10,617	9,841	15,444	423,833	39.7
Trans-Texas	23,435	5,585	43.7	16,831	9,515	33,752	594,719	44.6
West Coast	29,139	5,462	48.96	6,586	2,733	9,841	540,111	49.08
HAWAIIAN								
Aloha	17,316	2,322	55.8	2,239	.....	6,963	197,408	54.8
Hawaiian	37,869	5,604	59.6	5,050	.....	122,915	577,547	58.6
CARGO LINES								
AAXICO	.....	.....	.....	4,540	11,230	3,027,512	3,043,282	76.38
Aerovias Sud Americana*	.....	.....	.....	.....	.....	.....	.....	.....
Flying Tiger	3,041	15,263	100.0	42,028	62,598	12,372,170	14,003,060	85.1
Riddle								
Domestic	.....	.....	.....	9,546	32,963	3,831,142	3,873,651	74.1
Overseas	.....	.....	.....	.....	.....	539,122	539,122	50.9
Seaboard & Western	.....	.....	.....	487,285	.....	2,387,622	2,879,174	45.0
Slick	4,127	24,705	97.12	.....	.....	.....	2,470,483	97.12
HELICOPTER LINES								
Chicago Helicopter	17,140	315	52.9	1,320	.....	.....	31,402	44.1
Los Angeles Airways	4,072	130.4	56.2	5,191	2,339	.....	20,028	63.0
New York Airways	12,598	139	56.2	1,924	1,581	615	26,972	52.3
ALASKA LINES								
Alaska Airlines	10,360	9,411	62.5	56,942	3,403	206,634	1,195,249	52.5
Alaska Coastal	5,698	588	56.9	4,469	.....	4,442	68,697	60.0
Cordova	1,230	214	34.5	3,832	.....	49,594	73,337	41.0
Ellis	5,880	401	58.28	2,056	.....	2,723	45,329	65.9
Northern Consolidated	2,181	742	36.2	34,423	.....	70,881	185,603	55.4
Pacific Northern	11,354	10,650	51.2	119,772	8,557	302,439	1,584,957	62.0
Reeve Aleutian	1,435	1,262	44.5	31,600	.....	67,559	236,484	60.0
Wien Alaska	3,411	1,069	26.0	35,968	.....	308,872	453,615	60.9

*Not available.

Compiled by Aviation Week from Airline Reports to the Civil Aeronautics Board.

RAPID Mobility

with the STOL Caribou

The Caribou cabin will accommodate 32 troops.

•

The aircraft can take off with this impressive load in a distance of 530 feet. *(161.5 m.)*

•

It can move these men from place to place at a speed of 156 knots. *(289 kph.)*

•

Large rear loading door permits loading (or deplaning) 32 troops in 40 seconds.

•

A Caribou has loaded and unloaded 3 tons of cargo in 5 minutes total turn-around time. *(2722 kg.)*

•

In the new concept of lightning war, the Caribou's ability to move big loads in and out of small improvised landing strips quickly means greater concentration of our land forces through the use of RAPID MOBILITY.

DE HAVILLAND AIRCRAFT OF CANADA

DOWNSVIEW *ONTARIO*

SIX de Havilland Comet 4s have been ordered by Aerolineas Argentinas; three have been delivered. The 500 mph. (average speed) jet has a span of 115 ft., a length of 111 ft. 6 in. and height of 29 ft. 6 in. Capacity is 60-81 passengers. Typical stage length is 2,900 mi.

Aviation Week Pilot Report:

Power, Short Takeoff Mark Comet 4

By Robert I. Stanfield

Hatfield, England—Marked by an abundance of turbine power, de Havilland's 500-mph.-plus Comet 4 displayed good shortfield characteristics, rate of climb, and controllability through varied speed regimes and configurations during a flight evaluation by AVIATION WEEK.

Characteristics of the medium-range jet transport—in this instance the first Comet 4 production model—were sampled at altitudes up to 40,000 ft.

Power is supplied by four Rolls-Royce Avon fully anti-iced RA. 29 Mark 524 engines, each of 10,500 lb. takeoff thrust. The powerplant is a single-spool, straight jet, embracing a 16-stage compressor and a three-stage turbine.

At takeoff, engine speed is 8,000 rpm. and specific fuel consumption .763 lb./hr./lb. At maximum continuous thrust of 8,875 lb., engine speed is 7,550 rpm. and specific fuel consumption is .73 lb./hr./lb.

Features evidenced during flight evaluation by AVIATION WEEK included:

• **Takeoff and climb.** Grossing 120,000 lb., into a quartering wind of 12 kt., with outside air temperature 12C, the Comet 4 was airborne after a takeoff run of less than 3,000 ft. With engines turning 7,350 rpm. (maximum recommended climb-cruise) and airspeed holding to about 252 kt. indicated, the Comet climbed through 4,500 ft. at 4,000 fpm., 15,000 ft. at 2,500 fpm., 35,000 ft. at 1,400 fpm.

• **Engine-out capability.** At 10,000 ft., with gear down and 20 deg. flaps lowered, both starboard engines—numbers 3 and 4—were cut. Climbout on port engines, with power to 7,550 rpm., was initiated at 135 kt. Rate of climb was 500 fpm. About 8 deg. of rudder trim was utilized.

• **Pattern speeds.** With a ceiling of 1,400 ft., a coupled autopilot approach was made, via ILS. Descent during penetration was 1,500 fpm., with flaps lowered 20 deg. and airspeed indicating 136 kt. Circling pattern was flown at 124 kt., with 40 deg. of flaps. Final approach, with extension to 60 deg., was made at 120 kt. Comet was "over the fence" at 110 kt., where 80 deg. of flaps were lowered. Touchdown, with stall warning indicating, was at 98 kt. Weight on landing was slightly under 100,000 lb.

• **Noise level.** For a jet, the Comet is a reasonably quiet airplane, and flight was quite comfortable during ascent and level cruise. The airplane is fitted with Rolls-Royce corrugated nozzle noise suppressors which give a reduction in noise level of 3 to 5 db. There is no thrust loss on takeoff, rather an increase of consumption about 2.5 to 3%. During ground operation at high rpm., maximum noise occurs to rear of aircraft. At idling, on the ground, noise is radiated forward.

De Havilland offers the $3 million-plus airplane in three forms, to cover different operational roles:

• **Comet 4,** designed to carry 60 to 81 passengers on stages of up to 3,000 mi. at an average cruise speed of 500 mph. at 36,000 ft.

• **Comet 4B,** with a fuselage 6.5 ft. longer than the 4, and a wing span (no pod tanks) that is 7 ft. less than that of the 4. Airplane, with a higher speed averaging 530 mph. at 23,500 ft., will carry up to 102 passengers over shorter routes of from 400 to 2,500 mi.

• **Comet 4C,** with the wing span (115 ft.) of the 4, and the length (118 ft.) of the 4B. Payload of the 4C approximates that of the B; average speed of 500 mph. at 36,000 ft. is similar to that of the Comet 4. Typical stage length is about 2,400 mi.

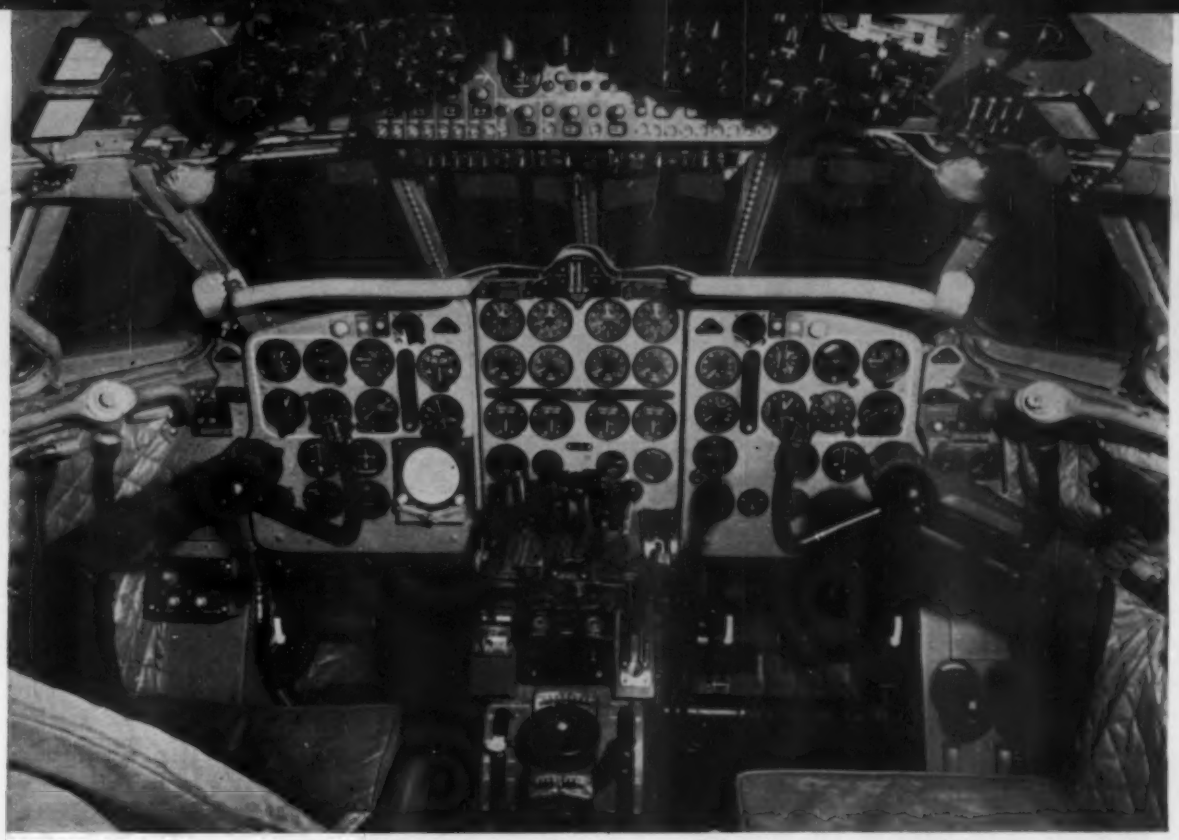
Maximum gross weight of all three aircraft is 156,000 lb. Maximum payloads are: Comet 4, 20,286 lb.; 4B, 24,610 lb.; 4C, 24,870 lb.

De Havilland has firm orders for 33

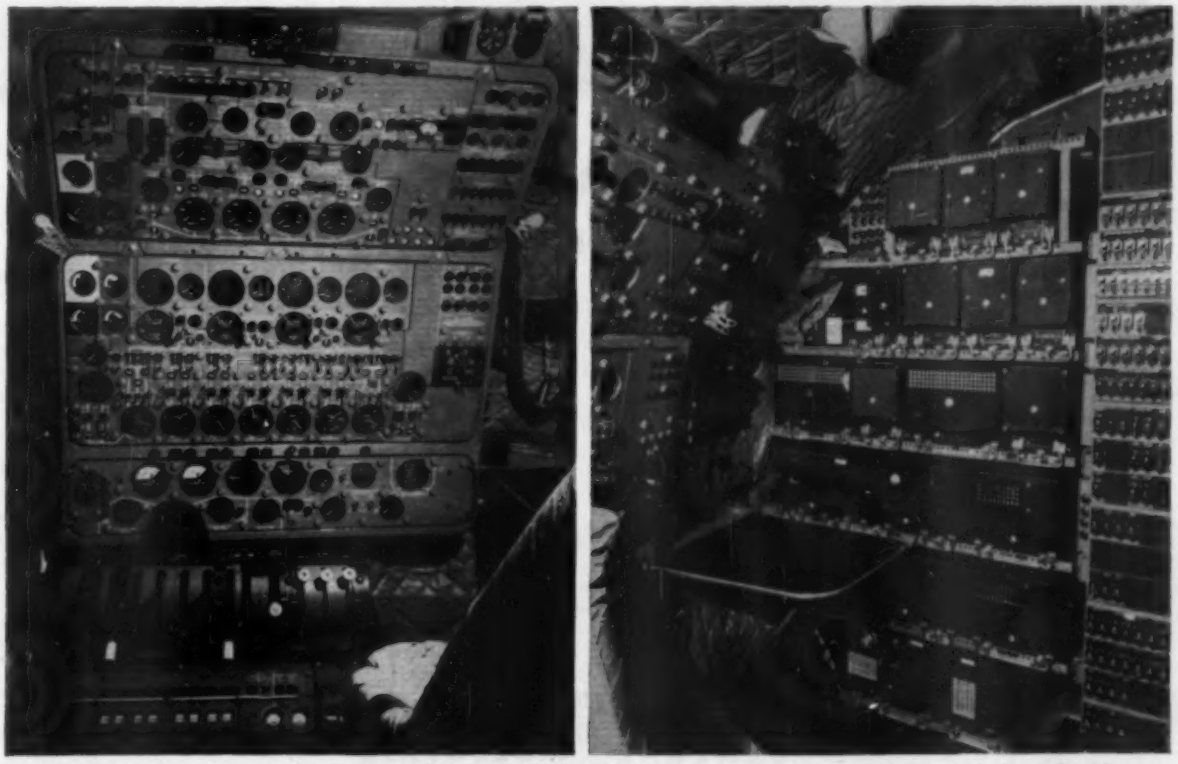
European Pilot Reports

This detailed pilot report on the de Havilland Comet 4 jet transport is the first of a series of nine such evaluations made in a five-week European tour by Aviation Week's Robert I. Stanfield. Other reports from this extensive tour including five nations will follow in succeeding issues of Aviation Week.

Metallurgical Memo from General Electric

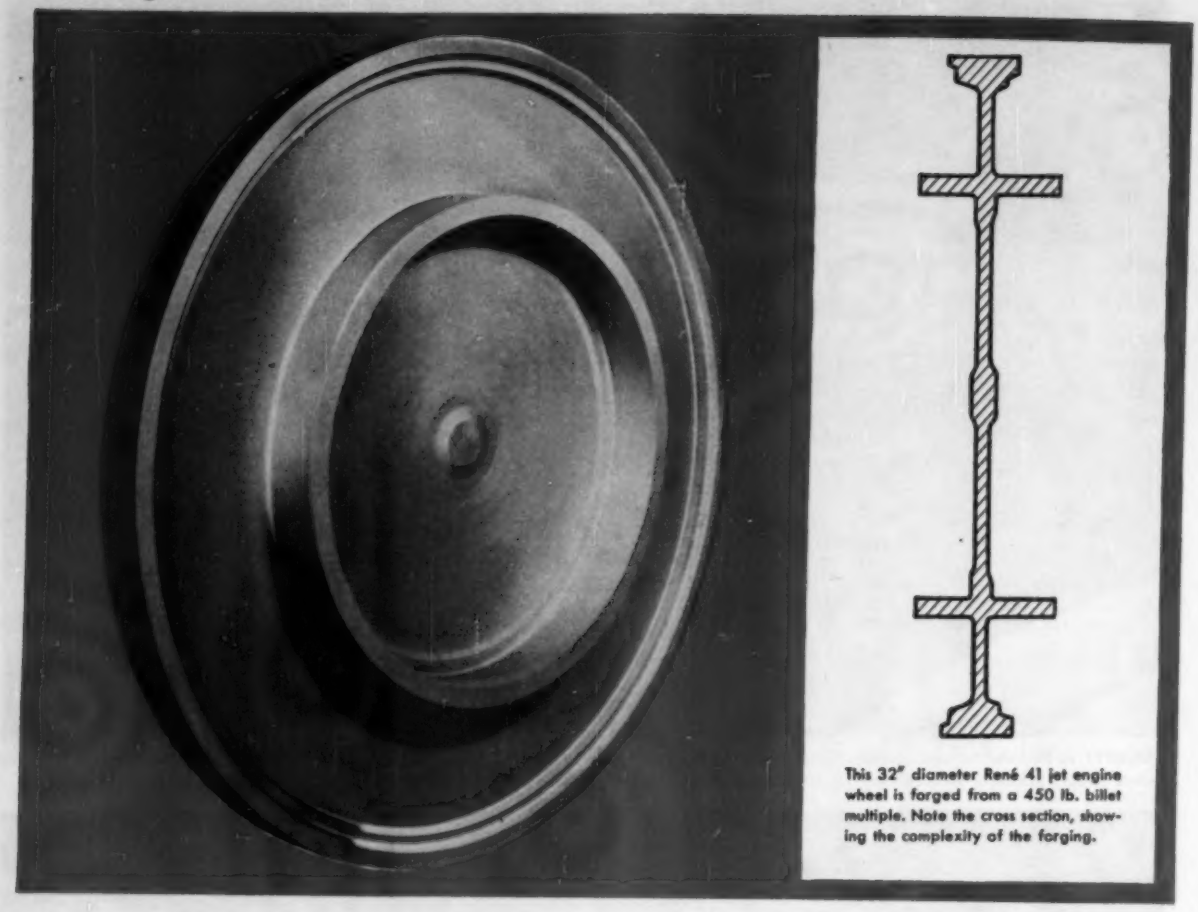


COCKPIT of British Overseas Airways Corp.'s first production Comet 4 is above. Note radar screen on captain's instrument panel. Servo power supply selectors are centered on the overhead panel, along with radio controls and engine and bay fire warning lights.



FLIGHT ENGINEER'S station in the Comet 4 (left) is behind the copilot's seat and includes pressurization and air conditioning controls. Circuit breakers are positioned against the aft bulkhead (at right in right photo), adjacent to the flight engineer's station.

Metallurgical Memo from General Electric



This 32″ diameter René 41 jet engine wheel is forged from a 450 lb. billet multiple. Note the cross section, showing the complexity of the forging.

WORKABILITY: the plus ingredient in General Electric's René 41

Metallurgical Products Department reports on a versatile high-temperature alloy that can be *forged* into heavy, complex shapes, drawn into fine wire, rolled into bar and sheet

General Electric's René 41* high-temperature alloy is one of the strongest materials that can be successfully formed, forged, or welded. It retains high strength even at 1800°F., yet can be forged into heavy, complex shapes. *No alloy with comparable mechanical properties can approach the workability of René 41.*

For example, complex jet engine wheels 32″ in diameter are being forged from 450 lb. multiples of René 41, vacuum-induction-melted by General Electric. These wheels, having a tensile strength of over 100,000 psi at 1650°F., must offer absolute dependability for pilot survival. René 41 is so ductile that it can also be drawn into wire as fine as .001″.

René 41 was developed by General Electric to extend the working range of high-temperature components, and is now being produced in quantity to the rigid quality standards required for the aviation industry. If you would like more technical information on René 41, write for Bulletin VM-107. Or contact: *Metallurgical Products Department of General Electric Company, 11107 E. 8 Mile Road, Detroit 32, Michigan.*

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CURRENT RATE of production of the Comet 4 at de Havilland's Hatfield plant, England, is two a month, which Hatfield shares with the company's Chester plant. Deliveries usually run 12 months from date of order. Company presently has 18 unsold aircraft.

Comets, and figures the break-even point to be between 60 and 70 aircraft. Nineteen Comet 4s have been ordered by BOAC, six by Aerolineas Argentinas and two by East African Airways Corp. BEA has ordered six of the Comet Bs.

To date 11 aircraft have been delivered to BOAC and three to Aerolineas Argentinas. Current production is at the rate of two a month (one each at de Havilland's Hatfield and Chester plants) and could be stepped up to six a month (four at Chester, two at Hatfield). Four aircraft are currently in the production line: one for BOAC and three for BEA. Deliveries usually run 12 months from date of order.

Company presently has 18 unsold aircraft.

De Havilland has built 19 Comet 1 and 1As, 10 Comet 2s and one Comet 3. The first Comet 4 flew on April 27, 1958. Less than five months later, the first two 4s were delivered to BOAC. The first of these, No. G-APDA, was flown by AVIATION WEEK.

The Comet is a beautiful, sleek looking aircraft. The RA. 29 engines initially went into service with an engine overhaul life of 1,000 hr., the result of preliminary flight testing on two Comet 2 aircraft converted for this purpose. Increase to 1,500 hr. is expected after a year's commercial service.

Fatigue Integrity

Early Comet 1 investigations, following the accidents in January and April of 1954, showed the cause as fuselage cabin fatigue failure (both, roughly, were flying at 30,000-35,000 ft.). Fatigue integrity has been a primary design aim of the Comet 4. The whole structure of this airplane has been thoroughly investigated both by calculation and by test.

Comet fuselage is pressurized to a differential of 8.75 psi. The fuselage is semi-monocoque of stressed skin, longitudinal stringers and transverse frames. Windows are oval shaped and, in vicinity of openings, basic skin thickness is 18 s.w.g., which is reinforced by doubling-plates around the actual cutouts, attached by Redux bonding.

Passenger doors and freight doors are parts of separate structures which are inserted into the pressure cell. Each insert is based on a skin-thickness of 16 s.w.g., strengthened round the cutouts by doubling-plates and door frames.

Thermal icing is effected by passing hot air through ducting in the leading edge structure. Engines are in the stub-wings, which also carry the main landing gear. Tailplanes and elevators are interchangeable and the vertical surfaces comprise a one-piece rudder and the upper portion of the fin. The lower part of the fin is integral with fuselage structure. Leading edge of fin and tailplane embody ducts for thermal deicing. Design incorporates 24S material in the lower booms of the spar and bottom skin of the wings.

Comet Engine Ratings

Rolls-Royce Avon RA. 29 will take-off rating of 10,500 lb. static thrust each at sea level I.S.A.

	RPM.	Jet Pipe Temp. (max.)
Maximum takeoff (5 min. limit)	8,000	615C
Maximum continuous	7,550	560C
Maximum recommended climb-cruise	7,350	
Minimum approach (unrestricted)	4,600	480C
Ground idling (unrestricted)	3,000	600C
Maximum overspeed (20 sec. limit)	8,250	
Maximum J.P.T. during starting		700C

Fuselage components and sections were subjected to tests representing six times the expected life in commercial operation. Complete Comet 4 aircraft has undergone pressure reversals, submerged in a water tank, for six times the expected working life. At this date the aircraft in the tank has reached 100,000 representative flying hours.

Spar Testing

Two front center section spars of the Comet 4 were tested, one of which stood without failure 10,000,000 cycles of 13 fps. gust loads superimposed upon a 1g load; the other 3,810,000 reversals of 17.5 fps. gust loads to failure. Tests represented a mean life of 2,930,000 hr. which corresponds to a safe life of 587,000 hr. assuming a 5.0 safety factor.

Tests to determine rate of crack propagation were carried out on a specimen panel containing windows. First period of the test was at a differential pressure of 9.75 psi., aimed at inducing a crack which did not appear until the equivalent of 186,750 flying hr. had been reached. Test was continued at 8.75 psi. The crack extended only ¾ in. after a further 30,000 flying hr.

The cockpit of the Comet 4 is roomy, comfortable, and fairly standard in layout. Flight instruments are located to the left and right of the main panel; engine instruments are centered. Center pedestal holds autopilot controls, air brake, flaps, aileron-rudder-elevator trim wheels. Radio controls and servo power supply selector are located on overhead panel.

Engineer's panel, aft of the copilot, includes pressurization and air conditioning controls. Circuit breakers are located on a wall panel. Top panel, centered above pedestal, contains light and deicing-defrosting switches, plus engine and bay smoke detector and fire warning lights. Fuel cocks are for-

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ward, at the base of the pedestal. Radar and ILS sit on the captain's instrument panel.

Flight controls are operated by duplicated hydraulic servo units, cable-connected to conventional controls. Mach trim is incorporated, which induces a temporary nose-up trim change should the never-exceed Mach number be attained. Rudder control incorporates duplicated yaw damping units and a mechanical rudder limiting device, the latter being automatically introduced at indicated speeds above approximately 185 kt. Balance tabs are fitted to ailerons and elevators.

A Smiths Flight System is installed, and integrated with SEP2D autopilot. Navigational equipment includes ADF, VOR/ILS, DME, Loran and search radar. Kelvin-Hughes stall-warning stick shaker is fitted to the captain's control column; two warning lights are located ahead of each pilot.

As with all turbines, starting procedures are simple and quick and engine light-up will occur 8-12 sec. after pressing the starter button. All four engines may be synchronized, with No. 1 or No. 4 as master. No. 1 is master when outer engines only are to be synchronized.

Field elevation at Hatfield is 250 ft. Single 6,000-ft. runway runs northeast-southwest. Wind at takeoff was from 30 deg. at 12 kt. Outside air temperature was 12C. Sea level pressure was 1,015 mb. Aircraft weight at takeoff was about 120,000 lb.

Along with AVIATION WEEK's pilot were John Cunningham, chief test pilot and a director of de Havilland, test pilot John Hanslip, and several passenger-technicians. Ceiling was about 1,400 ft., with tops at 3,200 ft. Visibility was 2 mi.

Twenty degrees of flaps were dropped and takeoff commenced from a rolling start. Speed built up rapidly and rudder control was effective about 65 kt. Nosewheel was pulled off about 90 kt. and the nose raised about 10 kt. below unstick speed, which was 110 kt. The Comet was airborne in less than 3,000 ft., climbing steeply.

Comet Specifications, Payload and Fuel Performance

SPECIFICATIONS	COMET 4B	COMET 4C
Over-all length	118 ft. 0 in.	118 ft. 0 in.
Height to top of fin (aircraft unloaded)	29 ft. 6 in.	29 ft. 6 in.
Span	107 ft. 10 in.	114 ft. 10 in.
Aspect ratio	5.63	6.33
Tailplane span	47 ft. 7 in.	47 ft. 7 in.
Height of intake lower lips	6 ft. approx.	6 ft. approx.
Height of door sills	9 ft. approx.	9 ft. approx.
Height of underfloor locker doors	5 ft. 6 in. approx.	5 ft. 6 in. approx.
Fuselage outer diameter	10 ft. 3 in.	10 ft. 3 in.
Wheelbase	53 ft. 2 in.	53 ft. 2 in.
Track	28 ft. 2 in.	28 ft. 2 in.
Main bogie wheelbase	45 in.	45 in.
Main bogie track forward	19.25 in.	19.25 in.
Main bogie track aft	16.25 in.	16.25 in.
Nosewheel track	18.2 in.	18.2 in.
Sweepback at ¼ chord	20 deg.	20 deg.
Thickness/chord ratio	11% average	11% average
Taper ratio	0.288	0.237
Gross wing area	2,039 sq. ft.	2,121 sq. ft.
Tailplane area	426 sq. ft.	426 sq. ft.
Elevator area	135.3 sq. ft. total	135.3 sq. ft. total
Fin area	141 sq. ft.	141 sq. ft.
Rudder area	36.9 sq. ft.	36.9 sq. ft.
Aileron area	52.1 sq. ft. each	60.6 sq. ft. each
Flap areas: plain flaps	208.2 sq. ft. total	208.2 sq. ft. total
split flaps	67.75 sq. ft. total	67.75 sq. ft. total
Aerodynamic mean chord	19.15 ft.	19.15 ft.
Distance of A.M.C. leading edge aft of transverse datum	3.43 ft.	3.9 ft.
Max. ground angle (static)	10 deg.–20 min.	10 deg.–20 min.
*Max. nosewheel angle (using cockpit control)	62 deg.	62 deg.
Min. pavement width for 180 deg. turn	105 ft. 0 in.	105 ft. 6 in.
Diameter of circle swept by outer wing tip in 180 deg. turn	158 ft.	175 ft.
PAYLOAD, FUEL PERFORMANCE		
No. passengers	72–102	72–102
Max. gross weight	156,000 lb.	156,000 lb.
Max. landing weight	118,300 lb.	118,300 lb.
Max. zero fuel weight	102,500 lb.	102,500 lb.
Capacity payload (72 seats 1st class)	19,700 lb.	20,500 lb.
Capacity payload (102 seats tourist)	24,610 lb.	24,870 lb.
Usable fuel	9,468 gal.	10,788 gal.
Usable oil	4.2 gal.	4.2 gal.
Typical stage length (1st class payload and full fuel reserves)	400–2,500 mi.	2,420 mi.
Average cruise speed	530 mph.	500 mph.
Average cruise altitude	23,500 ft.	36,000 ft.

*With nosewheel steering disconnected the nosewheel angle is unlimited (360 deg.)

Initial climb was at 170 kt. Power was reduced to 7,350 rpm. with gear up, and speed in climb increased to about 252 kt. indicated. Airplane climbed quickly through the thin cloud layer, at 4,500 fpm. Climb rates, to 40,000 ft., were 3,500 fpm. at 11,500 ft.; 1,700 fpm. at 28,000 ft.; 1,200 fpm. at 33,000 ft. (at which time the airplane was about 160 naut. mi. away from takeoff) and, at 40,000 ft., the airplane was ascending at 1,800 fpm.

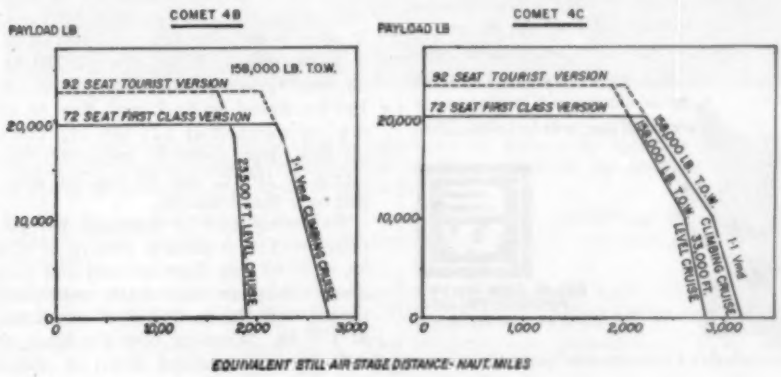
Cabin was quite comfortable during ascent, with noise level at a minimum. Visibility was good. At 40,000 ft. outside air temperature was minus 44C. Outboard engines sped at 7,500 rpm., inboards at 7,220 rpm. Exhaust gas temperature was 420C. With all engines to 7,000 rpm., EGT 400C, the airplane cruised at Mach .76. Cabin altitude here was 8,000 ft.

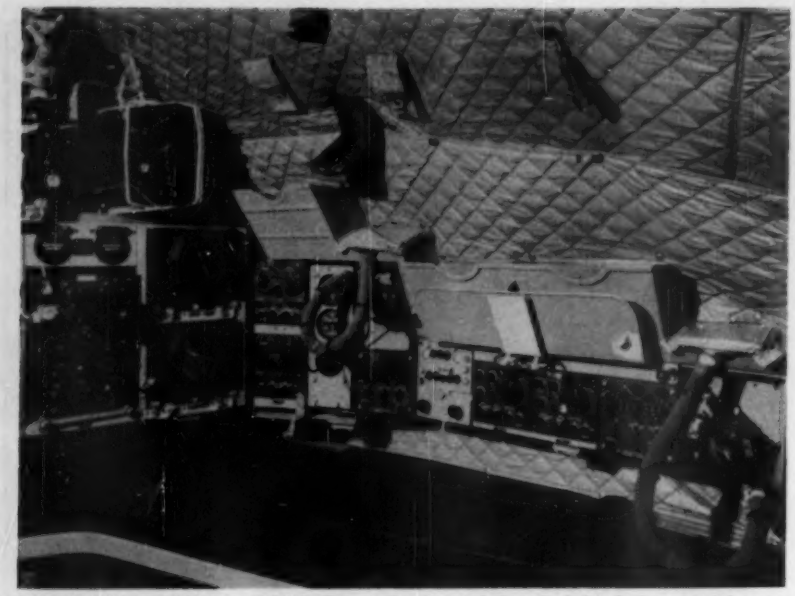
Comet 4 is redlined at Mach .78, and warning horn sounded as we approached this speed. The thrust on the Comet is limited only by the design speeds.

Initial descent began at 1,500 fpm. with the outboard engines to 6,900 rpm. and inboards to 3,750 rpm. Speed in descent was held to Mach .74 (220 kt. indicated). Using airbrake, the rate increased to 2,800 fpm. Rate will increase to 4,500 fpm. at 260 kt. indicated.

At 35,000 ft., outside air temperature minus 40C, engines turning 6,500 rpm., the Comet flew at Mach .74 (215 kt. indicated).

Never exceed speed (Vne) for the Comet 4 is 300 kt. indicated or Mach .78, whichever is lesser. Normal operating limit speed (Vno) is 270 kt. indi-





NAVIGATOR'S PANEL on BOAC Comet 4 is located directly behind the captain's seat. Navigational equipment includes ADF, VOR/ILS, DME, Loran, and search radar.

cated. Airplane showed good control tendencies at all speeds. Use of rudder was not necessary for normal flying and need not be used except with engine failure or during approach. Above 185 kt. IAS, rudder limiter operates automatically to restrict pedal movement to approximately 5 deg.

The yaw damper, used during flight and for landing, acts on the rudder alone, and automatically applies the correct amount of rudder for a given application of aileron. It eliminates Dutch roll at altitude and any tendency to yaw in turbulent conditions.

Comet 4 was stalled and engines cut out between 10,000-12,000 ft. In landing configuration, with 60 deg. flaps lowered and gear down, airplane was pulled up straight ahead with stall warning (stick shaker and light) and buffeting, including slight tail buffet, preceding (by 10 kt.) break which came at about 95 kt. indicated. Lateral control was good, wing easily held by aileron and rudder. Deliberate loss was about 500 ft., following which climbout was initiated.

Both starboard engines were cut, and flaps reduced to 20 deg. Power was advanced to 7,550 rpm. (max. continuous) and aircraft climbed out at 500 fpm., indicating 135 kt. The airplane easily was held straight by rudder pressure, which was negligible when the first engine was pulled. With two out, about 8 deg. of trim was applied. Response was smooth during varied degrees of bank, left and right.

Performance of the Comet 4 with BOAC handsomely exceeds de Havilland's guarantees, among which was that the airworthiness climb minima would permit a takeoff weight of 156,000 lb. at all airport altitudes and temperatures below 5,000 ft. and ISA (International Standard Atmosphere) 21C. Aircraft has complied with these minimums at altitudes up to 6,100 ft. and ISA 30C at this weight.

Also, in respect to its BOAC guarantees, the Comet 4 can take off from an airport 7% shorter, with a payload 3.5% greater (about 450 lb.), cruising 4 mph. faster and cover 190 stat. mi. (4.5%) more range than guaranteed. Results, confirmed by BOAC observers, note that the Comet's landing distance from 50 ft. to rest on a dry runway is about 1,050 ft. better than that guaranteed and 510 ft. better than the estimated performance quoted in the specification.

Flap Speeds

Maximum flap speeds for the Comet 4 are (all indicated) 210 kt. for 20 deg., 190 kt. for 30 deg., 170 kt. for 40 deg., 150 kt. for 60 deg., 140 kt. for 80 deg. Maximum for gear extension is 185 kt.

Speed usually is lowered to 210 kt. on field approach, base leg is flown at 140 kt. Speed on final, with flaps to 40 deg., is specified at 125-135 kt. With 60 deg. flaps lowered, speed will decrease by 10 kt., and 80 deg. are dropped over the threshold.

Following an ILS approach to Hatfield, we flew a circling pattern at 124 kt. with 40 deg. flaps lowered and gear down. Airplane was easily controlled during tight turns, and final was flown at 120 kt. We were over the fence at 110 kt. and touched down at about

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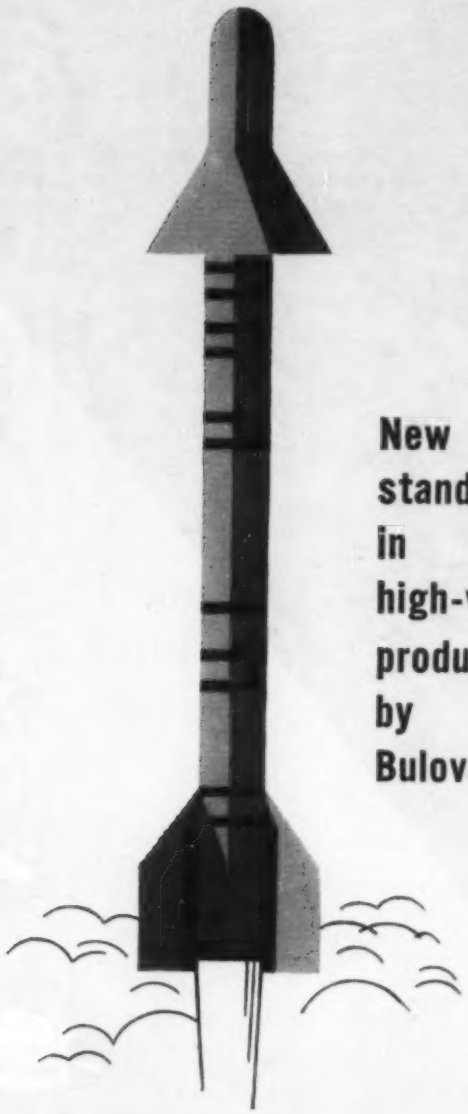
Jupiter missile developed by the Army Ballistic Missile Agency for operational use by the U. S. Air Force. Photo courtesy U. S. Army.



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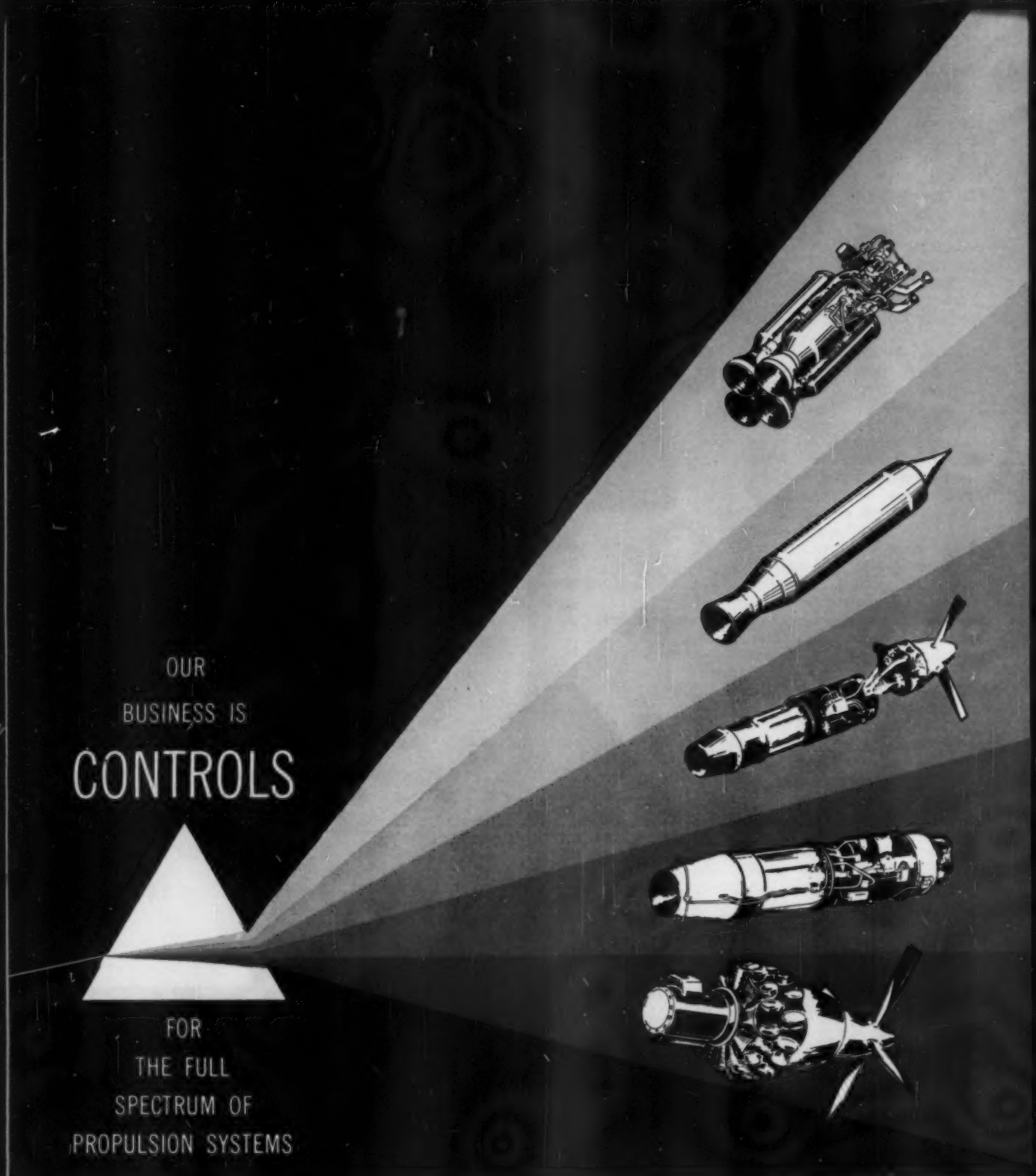

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98 kt., with a minimum of roll following touchdown.

De Havilland is now flying thrust reversers on an experimental basis. These will be installed as a modification on BOAC aircraft within a few months. Comet 3B, development aircraft for the Comet 4B, is fitted with two Rolls-Royce thrust reverser units on the outboard engines and has been brought to rest in 2,400 ft. after touchdown.

The Comet 4 holds 10,684 gal. of fuel, of which 42 gal. are unusable. Flexible center section tank holds 2,392 gal. Remaining tanks, integral, include inner wing tanks, 948 gal.; outer wing tanks, 1,681 gal.; extension wing tanks, 998 gal.; pod tanks, 519 gal.

Fuel is pressure fed by immersed pumps in each tank. Pod tank fuel is not used directly, but transferred to corresponding extension wing tank via immersed pumps. Until the contents of the extension tank are reduced by 1,760 lb. from full, transfer valves prevent entry from pod tanks.

Fuel can be fed independently or commonly to two engines in each wing, plus cross-feeding tank isolation and fuel jettisoning, for which the maximum speed is 200 kt. indicated. Dump rate (via compressed air) is 200 Imp. gal. per minute.

The Comet pressure refueling system provides an inflow of 200 gal. per min. per side. Connections are outboard of the main gear, under each wing. Control is via a panel in the wheel well. Provision also is made for over-wing refueling.

Comet engine and tailpipe mounting is isolated from the aircraft through rubber anti-vibration supports. Emphasis on design ensures that normal fuel drainage does not prevent a ground (or air) hazard on engine relight.

De Havilland tested its fire detection and extinguishing system by rigging engines in a tunnel and operating near 200 kt. simulated speed. Worst possible leak was simulated and ignition of fuel did not occur. Drainage of fuel from cowl was safe, with no spontaneous ignition.

Artificially, 1,000 gal. was ignited and easily extinguished. The adjoining engine was not affected, AVIATION WEEK was told. There was no tendency for fuel to flow from one zone to another in the engine, and no fire spread.

Ice detection in the Comet is via two Smiths detectors, plus visual inspection. In developing the engines, Rolls-Royce, in conjunction with de Havilland, incorporated fuel heaters, heated by compressor air, which ensured that fuel entering the engine filters and fuel system could be maintained at a temperature above 0C with a minimum of performance penalty.

Hot air is bled from each engine compressor to deice the engine, rectifier and engine bay air intakes and airfoil leading edges. (A tapping from this system ensures the fuel metering pitot heads are free of ice.) Instrument pitots are electrically heated. Gold Film elements are incorporated in the windshield panels.

Air conditioning via temperature-controlled air is also bled from engine compressors to the fuselage interior.

The Comet has five hydraulic systems: two engine driven pumps for normal operation, three for standby or emergency use. Two of the latter are powered by one electrically driven pump and the third employs twin manually operated pumps. Hydraulically powered services include flight control systems, flaps, air brakes, landing gear, nose wheel steering and brakes.

Power systems are pressure-regulated to 2,500 psi. by automatic cut-outs. Windshield wipers are operated by two separate electro-hydraulic systems.

The main electrical system operates at 24-28 v. dc. Rectified outputs of four engine-driven generators are connected in pairs to two main bus-bars which are normally linked. Six 24-v. batteries are normally in two parallel-connected groups, one for each main bus-bar.

External supplies at 28 and 120 v. can be connected for ground testing and engine starting. Starting also can be accomplished via batteries. Inverters, powered from the d.c. system, provide three-phase a.c. supplies. A three-phase a.c. generator is mounted on and driven by each engine.

Oxygen is via two systems, interconnected for charging purposes. Both are charged simultaneously to 1,800 psi. Non-return valves prevent transfer of contents between the systems. Stowage is provided for six portable oxygen sets. Should the cabin be depressurized at high altitude, the system operates automatically and masks are released.

Transall C.160 Dimensions Almost Equivalent to Those of C-130B

Paris—First details of the Transall C.160 turboprop transport being developed by a group of German and French companies show that the plane is dimensionally equivalent to the Lockheed C-130.

Observers at the 23rd International Aeronautical Salon at Le Bourget, where the model of the C. 160 was first shown (AW June 22, p. 76), were struck with the resemblance between the German-French paper design and the operational U.S. freighter. On checking dimensions, these technical observers were even more struck by the near-identity of some of the numbers.

Cargo volume of both airplanes is exactly the same at 4,300 cu. ft. Wingspan of the C.160 is 131 ft.; for the C-130B the span is 132.6 ft. Over-all length of the European project is 95.4 ft., and the Lockheed plane is 97.7 ft.

Major differences are in weight and powerplants. The C.160 weighs 90,500 lb. at takeoff compared with 135,000 lb. for the Hercules. Power for the C.160 will be a pair of Rolls-Royce Tyne turboprops. The C-130B uses four Allison T56-A-7 turboprops of 4,050 eshp. takeoff rating.

Irony of the situation is that the Germans have been cool to all of Lockheed's efforts to sell the C-130 on the ground that the Hercules is too big for the German mission.

Engineers close to the project report that the twin-engined configuration was chosen at the insistence of the French, who wanted to make the wing and powerplant installation the same as that of the proposed Breguet 1150 in order to simplify logistics. This also hints that wing and powerplant work will be done in France by Nord Aviation.

Requirements for the plane were established jointly by the French and German air forces. Primary roles are the transport of troops, parachutists, materiel and vehicles.

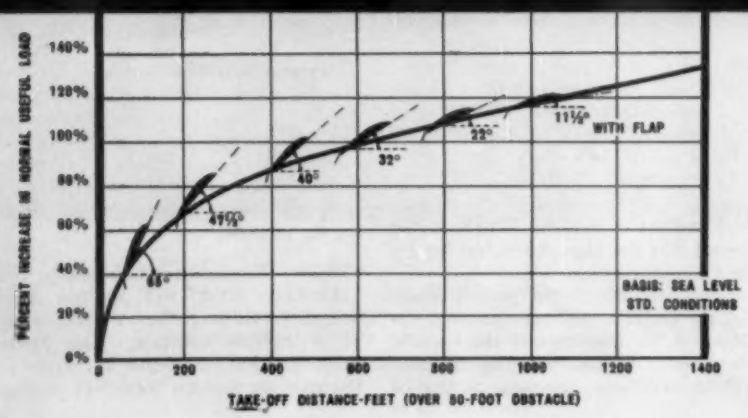
Transall is the name chosen for the group operations by three German and one French company: Blume-Leichtbau and Flugtechnik, Hamburger-Flugzeugbau, Weser Flugzeugbau and Nord Aviation. Weser has over-all responsibility for direction of the project.

PRODUCTION BRIEFING

Ward LaFrance Truck Corp., Elmira, N. Y., will build 90 tow tractors for Boeing B-52 aircraft under $3.5 million Air Force contract. The order follows contract for 109 similar vehicles.

Aeroproducts Operations of General Motors Allison Division will develop the 16¼ ft. four-bladed propeller for the Lockheed Super-Hercules under $4 million Air Force contract. Propeller will be fitted to the Allison T61 twin spool turboprop engine being developed for the aircraft.

Sperry Engineering Laboratory, Salt Lake City, Utah, will produce Army Sergeant solid-propellant missiles under $17.8 million contract. The Sperry Rand division's Sergeant contracts for the past six months total $44 million.



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Vertol achieved a major breakthrough in aircraft development during 1958, when its Model 76 (Army VZ-2) became the world's first tilt-wing vertical take-off and landing (VTOL) research aircraft to successfully complete conversion flights. In extensive tests since the first conversion flights, this tilt-wing design concept has also shown its effectiveness as a short take-off and landing (STOL) aircraft. Because the Vertol tilt-wing design qualifies in this dual role as a VTOL/STOL vehicle, it has tremendous potentials for both military and commercial aviation.

As a next step, Vertol can now build an operational type aircraft incorporating the tilt-wing principle, to explore more practically – through evaluation – the mission usefulness of any VTOL/STOL type aircraft.

In anti-submarine work, this versatile VTOL/STOL vehicle offers high forward speed plus the hovering characteristics necessary for effective completion of all phases of such missions, thus replacing – with one aircraft – the several different types currently required. The broad capabilities of the Vertol tilt-wing design also include application as an air truck. In an STOL role, it can take off and land with substantially increased gross weights and payloads. This unique capacity, combined with VTOL performance, permits the user to "custom tailor" his take-offs to altitude, temperature, available runway and load.

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In anti-submarine warfare, the tilt-wing design offers fast forward speed and hovering ability.

In its dual role as an STOL aircraft, the tilt-wing design could be utilized as a high load capacity air-truck.

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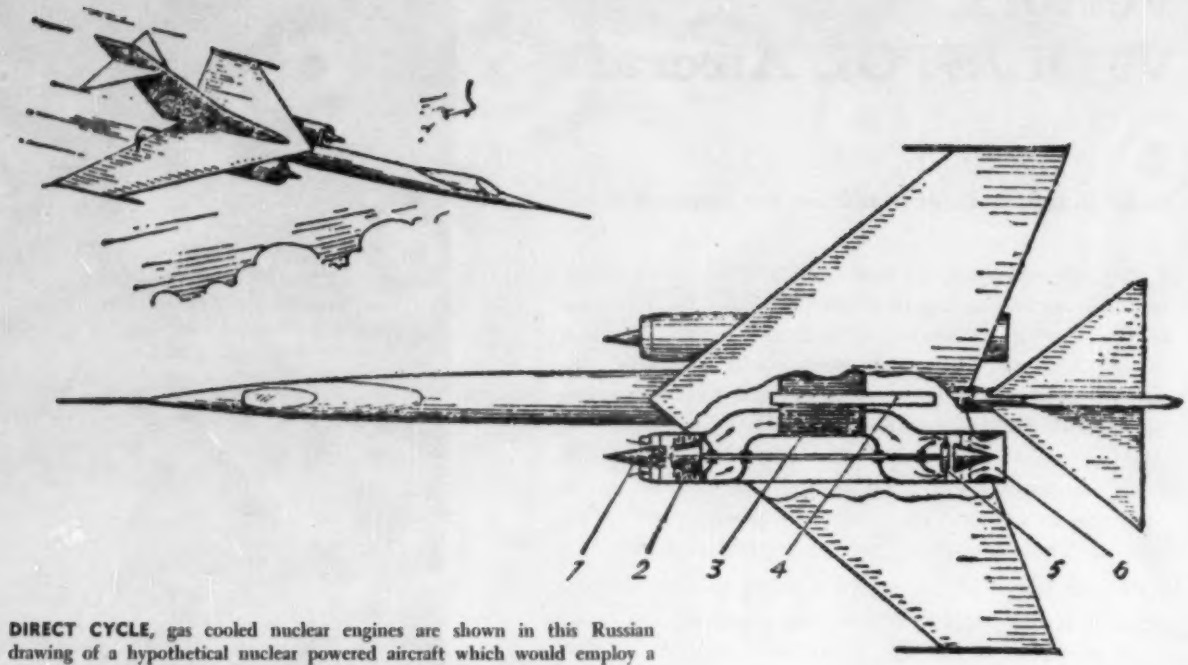
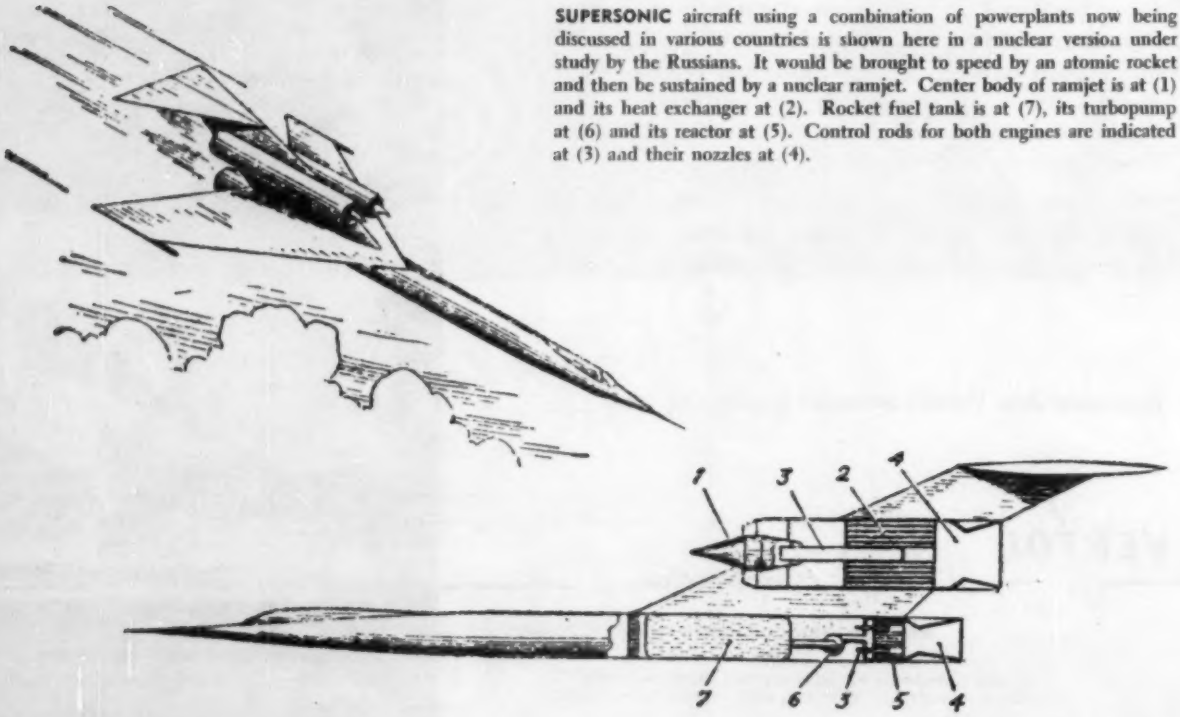
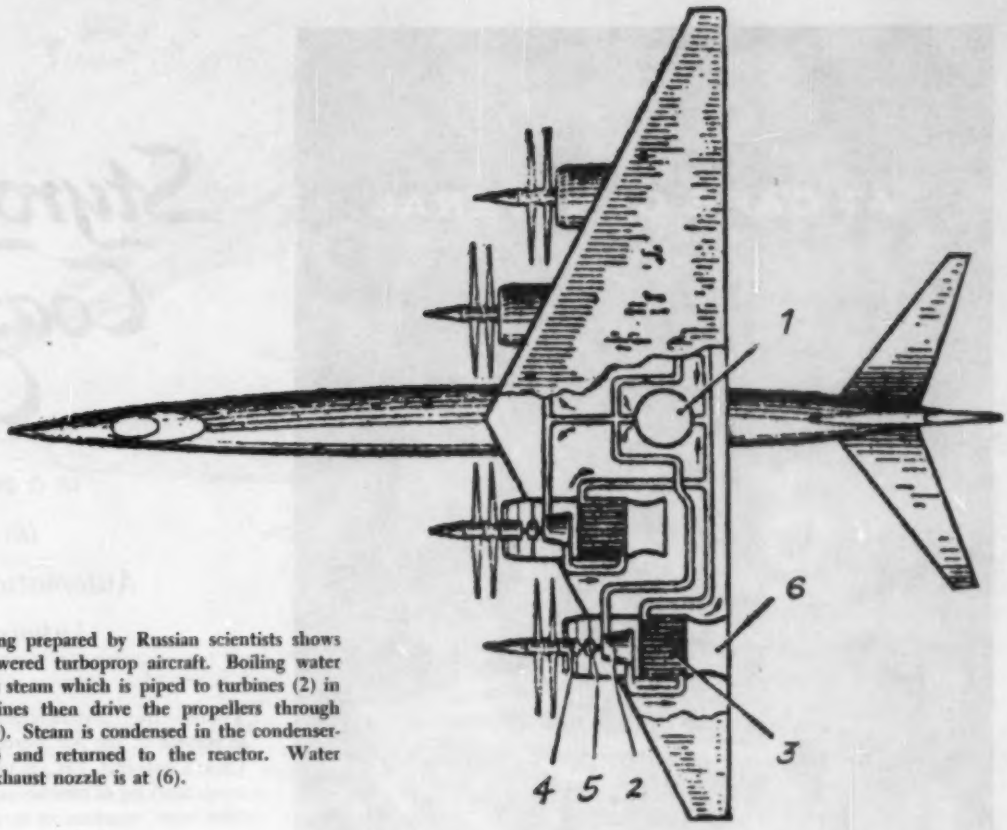


DIRECT CYCLE, gas cooled nuclear engines are shown in this Russian drawing of a hypothetical nuclear powered aircraft which would employ a single reactor. Air would enter the inlet (1), pass through the compressor (2), and then be ducted through the reactor (3), and out through the turbine (5) and the nozzle (6). Reactor rods are at (4). Single reactor would reduce shield weight in some designs, the Russians say.



SUPERSONIC aircraft using a combination of powerplants now being discussed in various countries is shown here in a nuclear version under study by the Russians. It would be brought to speed by an atomic rocket and then be sustained by a nuclear ramjet. Center body of ramjet is at (1) and its heat exchanger at (2). Rocket fuel tank is at (7), its turbopump at (6) and its reactor at (5). Control rods for both engines are indicated at (3) and their nozzles at (4).



SCHEMATIC drawing prepared by Russian scientists shows a nuclear steam powered turboprop aircraft. Boiling water reactor (1) produces steam which is piped to turbines (2) in each engine. Turbines then drive the propellers through reduction gearing (4). Steam is condensed in the condenser-heat exchangers (3) and returned to the reactor. Water pumps are at (5); exhaust nozzle is at (6).

Soviets Study Nuclear Plane Concepts

By J. S. Butz, Jr.

Washington—Numerous possible configurations for nuclear aircraft engines and airframes have been proposed by Soviet scientists. Most of the conclusions reached in these general studies show that Russian thought in this field parallels that in the U. S., for Soviet scientists apparently consider the direct and indirect cycle nuclear engines the most promising for aircraft propulsion.

Russian statements describe the direct cycle, in which the engine air passes directly through the reactor and is heated, as the simplest type of nuclear turbojet. Main drawback of this type of engine is that it requires a large heat exchanger type reactor because air is a very poor heat transfer medium.

This large reactor requirement then points to the use of a liquid metal heat transfer agent and the indirect cycle engine, according to the Russians.

The heat transfer surface required to heat the liquid metal is many times smaller than that required to heat air. Also, the temperature differential between the outer surface of the reactor and the liquid metal need be only a few degrees, or only a small fraction of the differential needed in the air type heat exchanger.

This means that a much smaller and lighter reactor can be used in the indirect cycle system. The disadvantage of this idea, however, is that the liquid metal heat transfer agent is quite heavy and two heat exchangers are required, one at the reactor to heat the metal and one at the turbojet engine for the metal to heat the engine air. The Russians describe this indirect cycle as "especially favorable in multi-engine aircraft, since the operation of more than one engine is possible with a single reactor."

Construction Problems

Numerous problems are connected with the construction of such engines but Russian literature two years old describes them as engineering, rather than scientific, problems, which corresponds to the most prevalent opinion in U. S. technical writing.

One of the most thorough Soviet articles dealing with virtually all aspects of the problem of building and operating a nuclear aircraft is entitled "Atomic Energy in Aviation" by Y. N. Sushkov. Sushkov is a colonel in the Red Air Force Engineering Service and was one of three authors of a rather detailed book, "Application of Atomic Engines in Aviation," published by the Military Publishing House of the USSR Ministry of Defense in 1957.

In the article "Atomic Energy in Aviation," Sushkov not only discussed the direct and indirect cycle in the manner described above but also covered a number of the other engine configurations which must be considered in any thorough study of nuclear propulsion possibilities for aircraft.

Most of these possibilities concern the use of an indirect type of cycle with the reactor heating a fluid or gas which not only passes through a heat exchanger in the engine to heat the propulsive air but also is used to turn a turbine which drives the engine air compressor. The main idea is to exhaust the air passing through the engine at the maximum possible temperature by not using it to drive the turbine after it passes through the heat exchanger.

A major problem with the idea, however, is that the helium used to trans-

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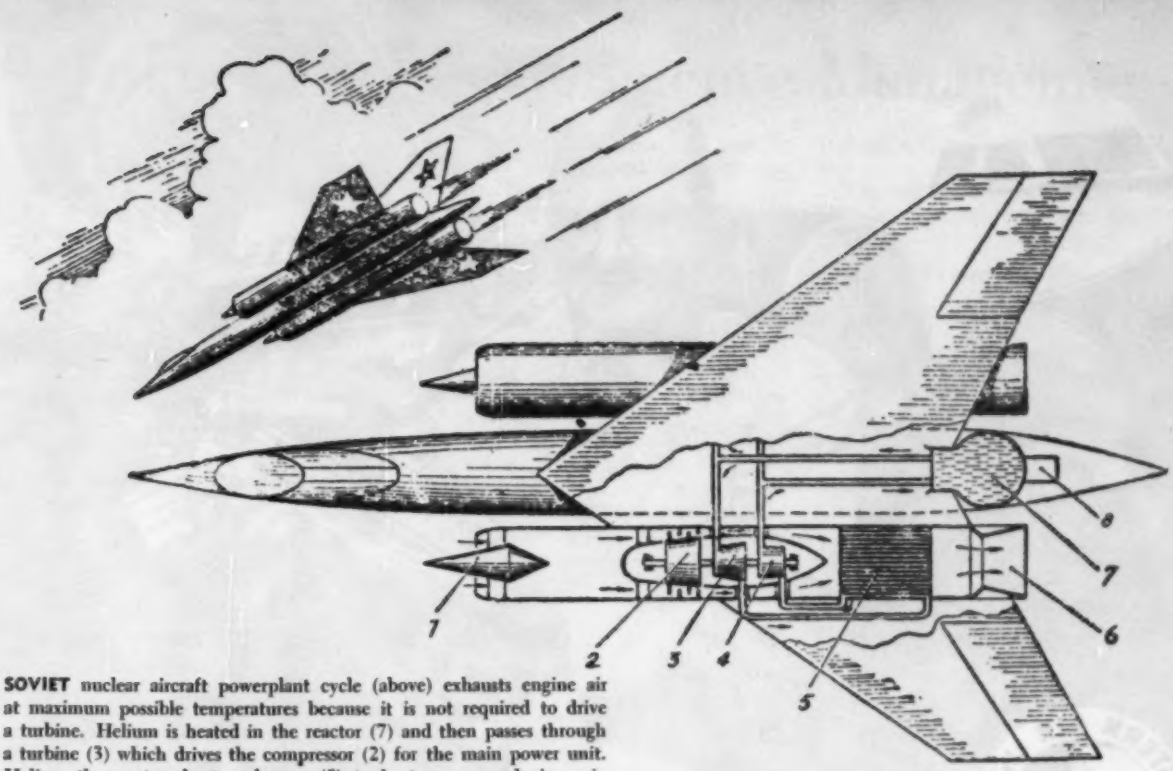

SOVIET nuclear aircraft powerplant cycle (above) exhausts engine air at maximum possible temperatures because it is not required to drive a turbine. Helium is heated in the reactor (7) and then passes through a turbine (3) which drives the compressor (2) for the main power unit. Helium then enters heat exchanger (5) to heat compressed air; main engine air then is exhausted out of the nozzle (6). Helium returns to the reactor after its pressure is raised in the compressor (4). Reactor rods are at (8) and centerbody of engine inlet is at (1).

fer energy from the reactor to the air heat exchanger in the turbojet and turn the jet's compressor must also have a compressor in its own cycle. This helium compressor requires more energy than the turbojet's air compressor in most designs. Sushkov points out that the efficiency of this arrangement is not very high.

A number of other fluids have been discussed for use in this system, such as mercury and water or steam. It is possible to decrease the consumption of nuclear fuel using these and other heat transfer agents, but they do not materially raise the over-all propulsive efficiency.

The Russians also have considered propeller driven nuclear aircraft with engines that externally resemble the conventional petroleum-fueled turboprop but actually are much different. This four-engine aircraft would use a single "boiling water" reactor which, according to Sushkov, "consists of a heavy pressure vessel containing ordinary water into which is placed a grid of enriched uranium rods encased in zirconium cladding."

The water moderates the fission process as it is heated into steam. The steam is ducted through the aircraft to the steam turbines in the engines which drive the propellers. Steam leaving the turbines must be condensed back to water before it returns to the reactor and this condenser-heat exchanger is located just behind the steam turbine. High speed air from the propeller blade roots is passed through a duct to this condenser.

The air then is exhausted through a nozzle and provides a slight bit of thrust due to the heat it picked up in the condenser.

Nuclear Ramjets

Another type of aircraft discussed by the Soviets would have two nuclear ramjets which are identical to the ordinary ramjet except that a heat exchanger reactor replaces the combustion chamber. This aircraft would be boosted to speed by a nuclear rocket in the hypothetical version discussed by Sushkov. This rocket is of the same general type being pursued in Project Rover in the U.S. and resembles in basic details the Kiwi-A reactor (AW June 29, p. 18). The reactor is gas cooled and the propellant is heated by pumping it through the reactor and then exhausting it out of a nozzle.

Sushkov also sketchily discussed the gaseous fuel concept for nuclear rockets and ramjets. In these engines, the fissionable material is mixed with the propellant or air, whichever the case may be, and then after it heats the working fluid the fissionable fuel is separated and not exhausted. The main problem with these engines, as pointed out by the Soviets, is that it is difficult to keep from losing a large portion of the fissionable gas, and a very large "combustion chamber" is needed for the gaseous fuel to heat the propellant.

It is theoretically possible to heat the propellant to extremely high temperatures with the fissionable gas and achieve specific impulses many times higher than those of the heat exchanger type nuclear rocket. This is because with the gas heating there are no temperature limitations due to the construction materials as there are with the radiator-like heat exchanger. Sushkov does not regard this type of engine as practical, but considerable thought is being devoted to it in Europe and the United States.

After discussing the problems of the atomic aircraft, Sushkov commented, "It is, in general, possible to build such an airplane, the atomic engines of which, with the reactor and protective shield, would not weigh more than the weight of ordinary engines with the necessary fuel for them. The minimum flying weight of an aircraft for which these conditions hold would probably be between 90-100 tons. The payload would be 5-10 tons, i. e., the aircraft would be able to transport from 50-100 tons."

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Soviets Reorganize Science Management

Washington—Soviet science is entering the USSR's next seven-year development period (1959-1965) with a new management setup for directing that nation's various research organizations and institutions; increasing manpower, financial and material resources; top-level pressure to conduct more research of economic significance in academic institutions, and a definite plan to direct research institutions and effort on a geographical basis.

The vital problem of managing scientific programs has been a subject of considerable debate within the top echelons of the Communist Party and the Soviet state in recent years. The scientist's view in these discussions has been well represented because approximately 50% of the more than 250,000 scientific workers who enjoy a privileged economic position in the Soviet Union are members of the Communist Party, as opposed to less than 5% of the total population of the USSR.

Decentralization

Outcome of the discussions apparently has been the decentralization of most research management. The institutions responsible for the individual projects are scheduled to exercise a much greater planning and administrative authority in the future. Passage of this detailed authority from a central source in Moscow to the various scientific institutions has been outlined in the official organ of the USSR Academy of Sciences.

V. A. Kirillin, head of the Science Division of the Communist Party, has also written in Pravda on the dangers and limitations of completely centralized control in science.

However, certain areas which the Soviets consider to be most important will continue to be under strong central control.

Controlled Fusion

Controlled fusion, high temperature metallurgical research, development of advanced computer ideas, and certain areas in chemistry are included in this high priority group, according to A. N. Nesmeyanov, president of the Academy of Sciences.

Most of the basic work connected with space flight and the exploration of space is also included in this high priority group.

Mechanism for planning research in the high priority areas also is being broadened at the central government level in Moscow. The Presidium of the USSR Academy of Sciences, which at one time had essentially complete authority over the planning of the most important scientific work, will now be joined by other groups in performing this function.

A document entitled "Basic Direction of Scientific Research in the USSR" will be drawn up to direct Soviet effort in various sciences. In the technologies, a group from the Academy of Sciences, the Ministry of Higher Education and the Scientific-Technical Committee of the USSR Council of Ministers will perform the planning function.

A group of specialists will then be assigned to direct and coordinate the work in each of the high priority areas covered in the plan. All work in their area, regardless of where it is being performed, will come under their jurisdiction.

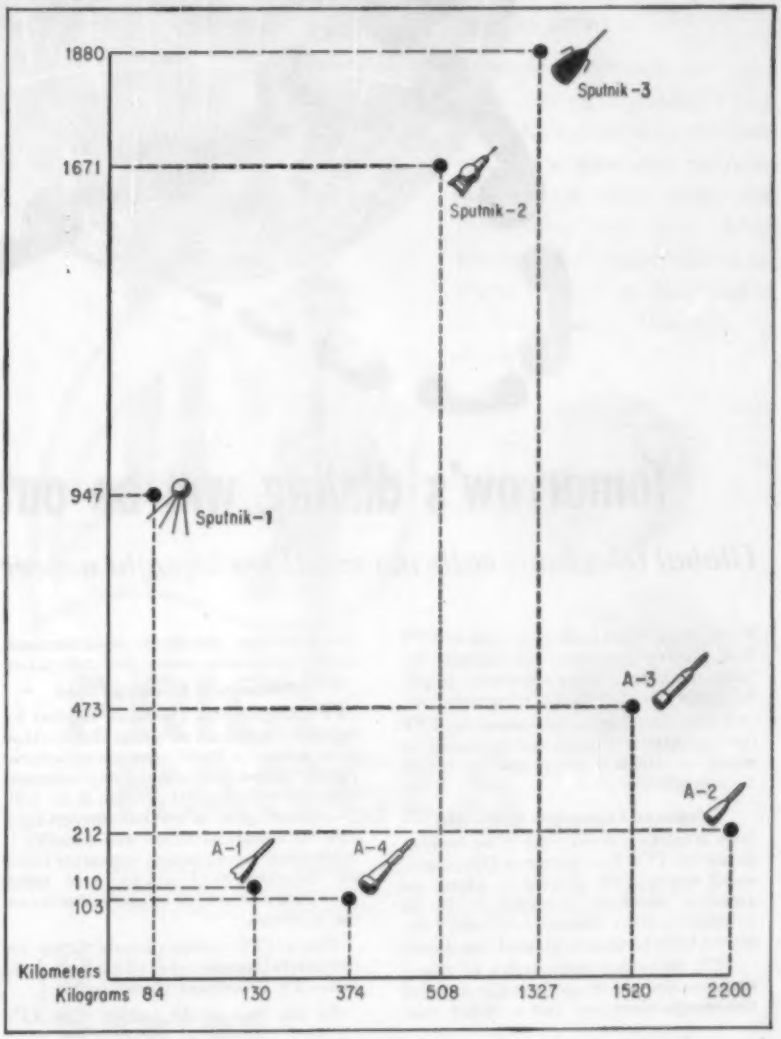
The top men in each of the areas will be a member of the directing committee.

Growing Resources

The extent of the Soviet scientific effort is illustrated by the fact that on Jan. 1, 1956, on the basis of what has been printed in open Russian sources, there were approximately 2,800 scientific institutions operated within the country.

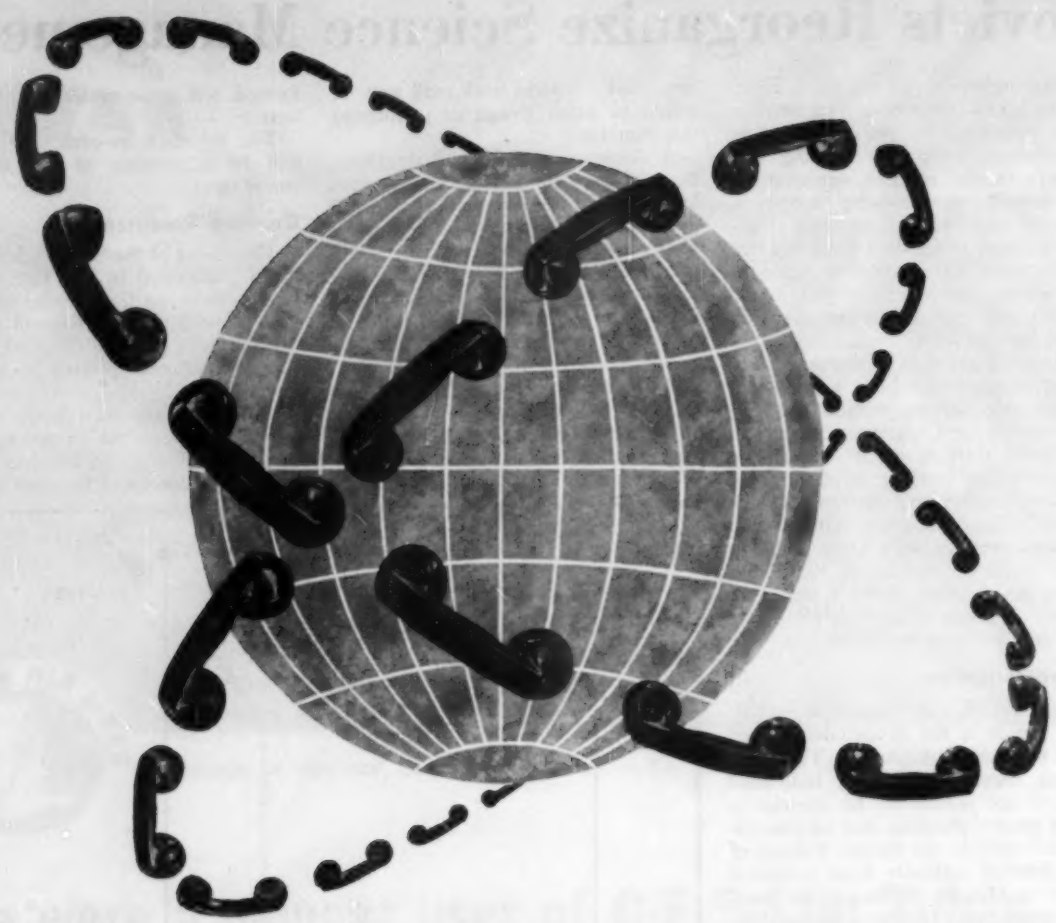
Of these, more than 1,000 were research institutes, which were distributed approximately as follows:

- **USSR Academy of Sciences** and the



Soviet Sputniks, Test Rockets Compared

Soviet chart shows altitudes achieved (in kilometers) and payloads carried (in kilograms) by Russian geophysical rockets in comparison with the USSR's three Sputniks. Geophysical rockets are A-1, A-2, A-3 and A-4.



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academies of the various republics, 309.

- **Industry,** 280.
- **Agriculture,** 101.
- **Health,** 226.
- **Education,** 55.
- **Building,** 32.
- **Other ministries** and departments, 61.

The remaining scientific establishments were distributed approximately in the following way: 146 were branches or subsidiaries of scientific research institutes; 574 scientific stations; 184 experimental field bases; 142 laboratories; 60 committees, section councils and commissions; 392 museums engaged in scientific work, 38 observatories; 74 nature conservation establishments; 61 libraries engaged in scientific work, and 64 miscellaneous.

The total number of scientific establishments increased by more than 200 in the period from Jan. 1, 1956, to Jan. 1, 1958, bringing the total to more than 3,000 today.

Scientific Community

The Soviet scientific community and its institutions as described above are organized into three main systems: The USSR Academy of Sciences and the academies of the various union republics, research establishments in industry and agriculture and the institutes of higher education.

The best estimates of the number of technically trained scientific personnel working in these three systems at the start of 1959, based on open Soviet literature, are:

- **Scientific institutions** of the academies, 125,000.
- **Scientists in institutions** of higher education, 145,000.
- **Industrial enterprises** and the administrative systems, 10,000. (The bulk of the more than 750,000 engineers listed by the Soviet Union work in industry.)

This total of 280,000 shows an increase of about 45,000 over the total at the beginning of 1956.

It is virtually impossible to determine what sums of money are spent on scientific activity in Russia through an investigation of material published by the Soviet government. The main sources of scientific support are the state budgets, all-union, union republics and local. A great deal of money is funneled into the scientific effort because industrial enterprises raise the price of their goods to support their scientific projects.

Budgets for the institutions of higher learning contain the funds for their scientific work but it is never clear just what these funds amount to. Still other large sums for science to support such activities as those in the space program are apparently never in the published state budget even in hidden form.

On the basis of scientific funds that are visible in the various budgets of the

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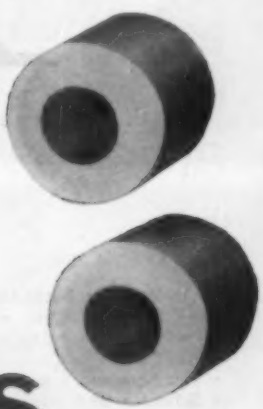

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Soviet Union and its political subdivisions, it is apparent that a great effort has been made since World War II to give science a blank check. The scientific expenditures are due to rise again during the next seven-year plan.

The consolidated state budget has shown a steady increase in expenditures for scientific research excluding capital construction. Before World War II, this expenditure was less than 1% of the state budget and under the 1959 plan it is 3.3% of the total. This amounts to 23.1 billion rubles, which, at the official Russian rate of exchange of four rubles to the dollar, would be more than $5 billion. The exact buying power of the ruble in comparison with the dollar is very difficult to ascertain but it seems certain that the above conversion gives a false picture.

Realistic Exchange

The Russians allow tourists a 10 ruble to the dollar rate of exchange and Americans who have lived in Moscow for long periods claim that a more realistic exchange would be about 13 to 1 when buying power is considered.

A still more indicative exchange is offered on the black market in Moscow at 20 rubles to the dollar.

If either of these last two rates of exchange is a fair comparison of the buying power of the ruble and the dollar, in a scientific operation it would mean that the "basic" expenditure of the Soviet state for science would be between $1.1 and $1.6 billion during 1959.

It is stated by Soviet sources that this sum does not include the funds for scientific research in institutions of higher learning.

Students of the Soviet science program say that a good estimate of the total funds allotted for purely scientific pursuits and the construction and equipping of scientific facilities is about 34 billion rubles. It is also estimated that about 70% of this total or about 23 billion rubles is spent on research of direct benefit to the military posture of the Soviet Union.

The budget of the ranking scientific organization in the USSR, the Academy of Sciences, has increased 32 times between 1932 and 1958 according to the academician Topchiyev, Secretary of the Academy. In absolute terms the Academy's budget grew to about 1.3 million rubles in 1958.

One of the most important aspects of the known Soviet expenditures for science is the rate of increase. On the basis of the recent past, the funds available for science will at least double during the next seven-year period. This would result in an annual expenditure of 46 billion rubles or more by 1965. A major portion of this sum apparently

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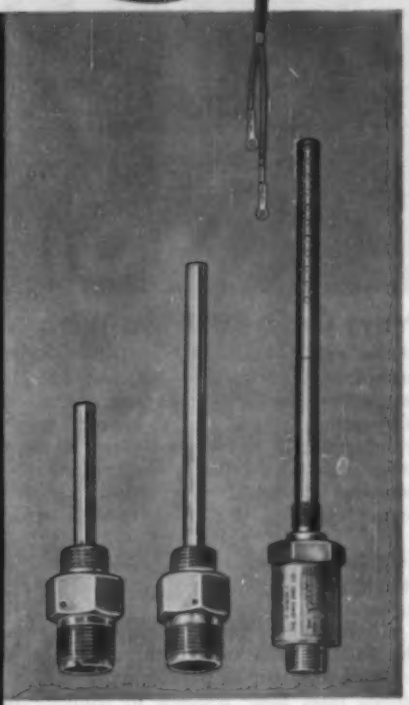

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Navy Orders P5M-2s With Advanced ASW Detection

Martin will produce P5M-2 anti-submarine warfare seaplanes equipped with a new submarine detection system for Navy under a $23 million contract. The system is designed to detect submarines over greater ranges than currently possible with existing Navy patrol aircraft. Pod under port wing of this P5M-2 contains a camera for recording damage to an enemy during day or night operations. Searchlight is mounted under starboard wingtip. Magnetic airborne detection unit extends aft from root of horizontal stabilizers. Nose radome contains ASW radar scanner. Radome aft of cockpit appears to be for electronic countermeasures equipment.

will be directed toward developing atomic energy and especially controlled fusion.

Considerable pressure is reported in the Soviet Union from both scientists and non-scientists to transfer more scientists from basic research to studies which have more "economic significance." It has been proposed by a number of leading figures that the largest group of scientists in the country, the 145,000 or so in the universities, be brought more closely into the economic picture and have them work directly on the most pressing problems facing industry. It has been estimated that in 1955 less than 10% of the effort of these university scientists was devoted to work of direct economic significance.

Technical Leadership

Nesmeyanov is one of the men pushing for this employment of scientists. He points out that Germany and the United States reached their high states of technical progress primarily through the work that was done in institutions of higher learning. He pointed out that in both nations the technical leadership of the universities has been vital. As an example he cited that the first cyclotron, first radar, and first gas turbine were created in American schools.

It is noteworthy that the USSR Ministry of Higher Learning now is a prominent member of the top scientific planning bodies in the Soviet Union.

Much of the non-scientist criticism of technical activity has been voiced through the state-controlled press. Public censure in the newspapers has become a standard prelude in Russia to major reorganizations of industrial enterprises and to the removal of individuals from their jobs. Recent stories in Izvestia have found great fault in the operation of a number of design bureaus and research institutes and with the performance of some individuals working in them.

Izvestia has borrowed from author Sinclair Lewis in describing smug engineers and scientists as "Babbitts." The newspaper said that educated goldbrickers, after earning university degrees, are "taking cover in the complexity of the problems they are supposed to solve," producing nothing and at the same time blocking the advancement of younger, more talented men. It was suggested by Izvestia that there are two ways to rectify the situation: either putting experimental work on a cost accounting basis or having "public organizations . . . remove all who are simply husks." These public organizations presumably are Communist Party units.

Two of the institutions cited by Izvestia as being ineffective were the Experimental Machine Building Institute and the Central Heavy Machinery Research Institute. Typical of the criticism of individuals was that directed at Valerian Petrovich, about 45, who has been on the staff of the Experimental Machine Building Institute for the last five years. According to Izvestia he has been working on a single theoretical problem all of this time but the period has been "fruitless, there has been no gleam of novelty in his experiments, nothing that could interest foundry men."

Izvestia also complimented the institutes that it criticized for a number of projects they had completed but it also implied that the institutes retain inefficient staff personnel because they are unwilling to "wash their dirty linen in public." The newspaper added, ". . . hushing up of things often gives rise to lobbying, gossip, complaints, stool-pigeoning, squabbling and bickering."

Scientific Planning

Sectionalism, which is perhaps stronger in the Soviet Union than any nation today, has created pressures in scientific planning as well as other aspects of government. Existing scientific establishments are being strengthened in border areas of the USSR and more are being created. This applies to the region of the Caucasus Mountains, the area east of the Caspian Sea bordering on Iran and Afganistan and in the eastern regions of Siberia.

Complete scientific towns are being created, one in Irkutsk with chemical engineering and geological emphasis, in Novosibirsk with physical engineering emphasis and in Puschino with physical chemistry and biological emphasis.

Such development not only eases sectionalist pressures but reduces the strategically unwise concentration of science and industry near Leningrad and in the Moscow, Gorky, Kuibyshev triangle in Great Russia.

2-mi. Linear Accelerator Will Cost $100 Million

Congressional authorization for construction of a two-mile-long linear accelerator at Stanford University costing an estimated $100 million will be sought by the Atomic Energy Commission. In addition to construction costs, it is estimated that $18 million will be required for research and development plus $15 million annually for its operation. The accelerator will be capable of producing 10 to 15 billion electron volts initially and 45 billion electron volts eventually.

Steady, there!

Because his motor control system is inadequate to "orbital" conditions, the happy fellow above may well feel more than a little "out of this world". His old familiar muscles are incapable of providing the precise, reliable control he needs.

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In testing the efficiency of liquid oxygen tank vent valves developed for missiles, Stewart-Warner utilized Air Reduction liquid nitrogen as a "stand-in" for liquid oxygen.

The reasons why were good ones: the data on easy-to-work-with nitrogen could be applied to predict the behavior of oxygen under similar conditions; nitrogen does not combine easily; it is incombustible.

In the vital leakage tests of the valves, Air Reduction helium was employed. Complete tightness of the shutoff mechanism was mandatory, and the high diffusion rate of helium best qualified it to serve in this phase of the testing operation.

In order to assure a steady supply of nitrogen and helium, Air Reduction's Technical Service Organization set up, adjacent to the Stewart-Warner laboratory, both a permanent installation for liquid nitrogen and a helium manifold.

This is but one area of cryogenics where Air Reduction gases—and technical knowledge—are being used extensively. Here, as elsewhere, a principal feature of Airco Industrial Gas Service is absolute dependability of supply.

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Refrigeration equipment for further tests. Choice of Airco assures dependable supply of industrial gases for *cryogenic* testing—from the Greek word meaning, "Creation of icy cold."

Test data and control panel. Under such precision controls, Airco gases are advancing frontiers in many industries such as missiles, aircraft, electronics, steel, chemicals, and food processing.

Airco's liquid nitrogen installation at the Stewart-Warner cryogenics lab, in Indianapolis. Helium manifold far right. These facilities make it practical to maintain reserves of both vital gases.

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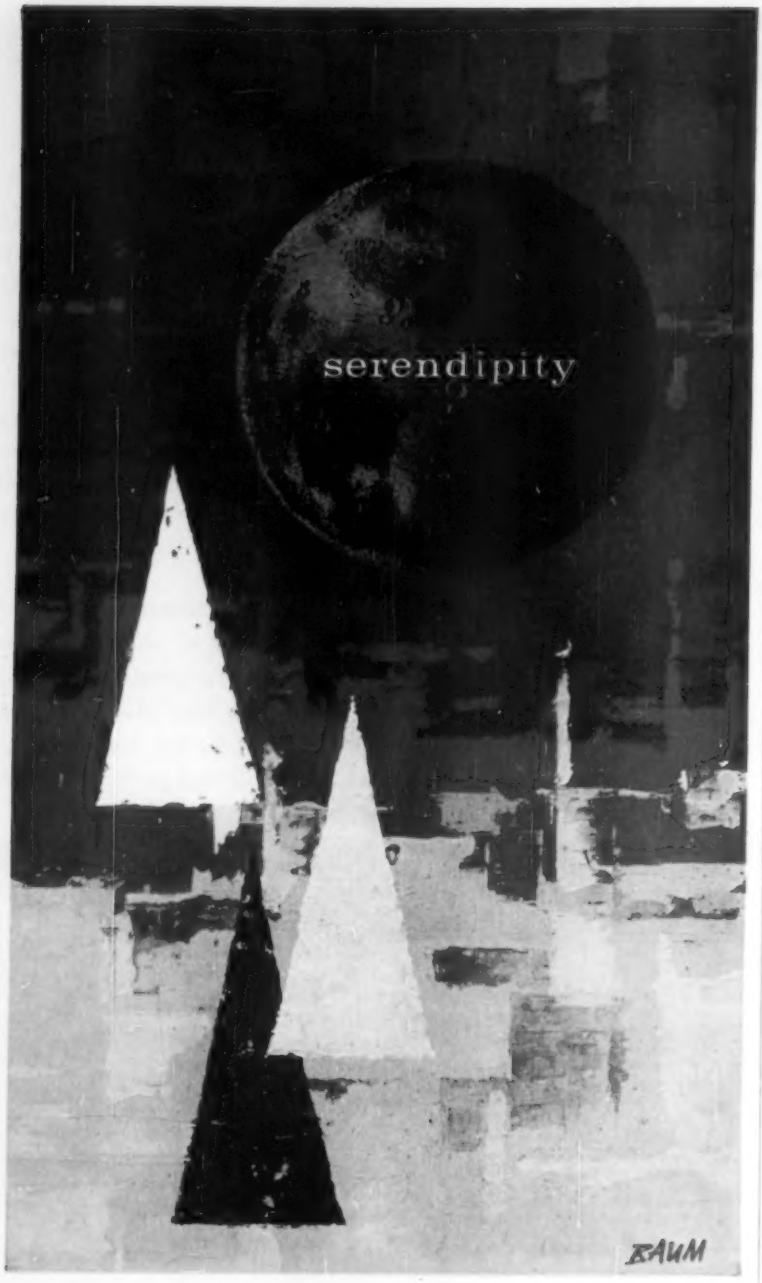

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ARPA Contracts

Washington—Following is a list of projects funded by the Advanced Research Projects Agency as of April 30, 1959.

EXPLORATORY RESEARCH.

Stagnation point ballistics, U. S. Army Research and Development, Metallbau Semler, Munich, Germany, $290,000; properties of materials at low temperatures, U. S. Department of Commerce, Bureau of Standards, (in-house), $184,000; nine studies in space power research, Army Signal Corps, no contractors listed, $961,000; study in space power research, U. S. Navy, Bureau of Ships, no contractors listed, $200,000; research in high temperatures and pressures, Naval Ordnance Laboratory, Bjorksten Research Laboratories, Inc., $115,000; feasibility studies (space propulsion and power sources), Office of Naval Research, Princeton University, Curtiss-Wright Corp., Republic Aviation Corp. and University of California, $413,000.

Feasibility studies (Project Orion, advanced space propulsion and power sources), Air Research and Development Command, General Atomic Division, General Dynamics Corp., Aerojet-General Corp., Reaction Motors Division, Thiokol Chemical Corp., Plasmadyne Corp., Aeronutronic Systems, Inc., Atlantic Research Corp., Avco Research Laboratory of Avco Manufacturing Corp., Rocketdyne Division, North American Aviation, Inc., Fairchild Engine & Aircraft Corp., Aero-Chem Research, Vidya Associates, Radio Corp. of America, $2,809,000; feasibility studies (heat rejection from space vehicles, advanced power sources), Army Ordnance Missile Command, Electro-Optical Systems, $182,000; Magnus effect study, U. S. Navy Bureau of Aeronautics, Flettner Aircraft Corp., $28,000; plasma electron study, U. S. Army Research and Development, Battelle Memorial Institute, Frankfurt, Germany, $307,000.

Total: $5,489,000.

SOLID PROPELLANT TECHNOLOGY.

Studies of light element compounds, U. S. Department of Commerce, National Bureau of Standards, (in-house), $500,000; solid propellant research, U. S. Navy Bureau of Ordnance, Minnesota Mining & Manufacturing Co., American Cyanamid Co., Aeronutronic Systems, Applied Physics Laboratory, Magna Propulsion, Atlantic Research Corp., Olin Mathieson Chemical Corp., New York University, U. S. Navy (in-house), Allegany Ballistics Laboratory (in-house) and Naval Ordnance Test Station and Naval Ordnance Laboratory (in-house), $5,201,000.

Solid propellant research, Office of Naval Research, Ohio State University, Princeton University, Aerojet-General Corp., Aerochemical Research Laboratory, University of California, Polytechnic Institute of Brooklyn and Pennsylvania State University, $700,000.

Solid propellant research, Air Research and Development Command, Dow Chemical Co., Callery Chemical Co., Monsanto Chemical Corp., Pennsalt Corp., Borden Co., Peninsular Chemresearch, Ethyl Corp., Atlantic Research Corp., National Research Corp., University of Texas, Stanford Research Institute, Aerojet-General Corp., University of California, Materials Research Corp., Materials Laboratory, U. S. Air Force—Wright Air Development Center (in-house), and U. S. Air Force (in-house), $3,910,000.

Solid propellant research, Army Ordnance Command, ESSO Research and Engineering, Allied Chemical Corp., Olin Mathieson Chemical Corp., U. S. Army (in-house), and Rohm & Haas (in-house), $3,267,000; solid propellant research, U. S. Army Office of Ordnance Research, University of Chicago, Duke University, A. D. Little, Vanderbilt University and University of Florida, $630,000; solid propellant research, U. S. Department of the Interior Bureau of Mines, (in-house), $215,000.

Total $14,423,000.

Total estimated project funding by Advanced Research Projects Agency through fiscal year 1959: $410,445,000.

Technicality Costs NASA $22.7 Million

Washington—Funds requested by the National Aeronautics and Space Administration for Fiscal 1960 were cut back another $22.7 million in the House when Rep. H. R. Gross (R.-Iowa) raised a point of order regarding previous authorizations.

The House Appropriations Committee earlier had cut NASA's requests for Fiscal 1960, plus a $45 million 1959 supplemental, from $530.3 million to $484.8 million. Gross' maneuver cut the final amount to $462 million.

Of the total approved, $91.4 million is for salaries and expenses, $318.6 million for research and development and $52 million for construction and equipment.

Originally, the Appropriations Committee had recommended the following breakdown:

- **Salaries and expenses**—$91.4 million, a reduction of $3 million from the amount NASA requested.
- **Research and development**—$300 million, a cut of $33 million from requests.
- **Construction and equipment**—$52 million, a reduction of $5.8 million from requests.
- **Research and development,** 1959 supplemental—$18.6 million, a reduction of $2 million.
- **Construction and equipment,** 1959 supplemental—$22.7 million, a reduction of $1.5 million from requests.

During floor consideration of the 1959 supplemental funds, however, Gross raised a point of order against the language of the bill on the grounds that previous authorization of the supplemental was voided by the language contained in the bill authorizing the Fiscal 1960 appropriations.

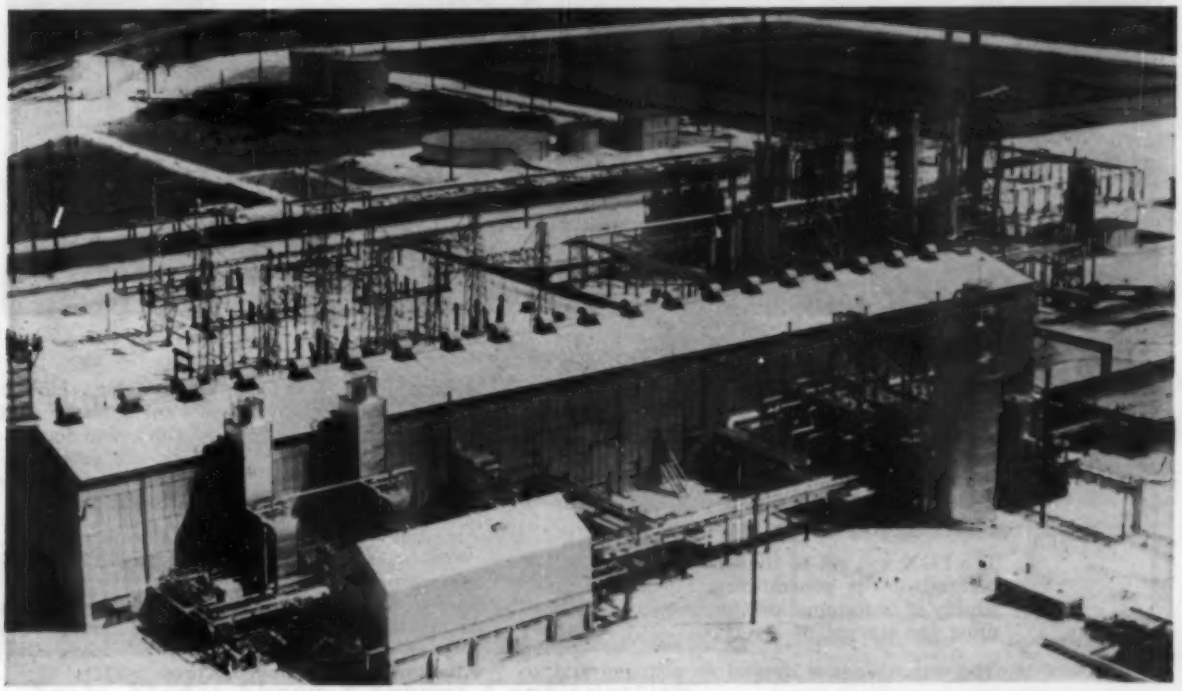
He said the Fiscal 1960 authorization bill, which became law June 15, stated that no appropriations may be made to NASA unless "previously authorized by legislation hereafter enacted by the Congress." He added that authorization for the supplemental portion of NASA's requests did exist at one time, but was repealed by the words "hereafter enacted," meaning after June 15

Gross first raised the point during debate on the $18.6 million for research and development and was conceded by Rep. Albert Thomas (D.-Tex.) chairman of the Appropriations subcommittee considering the requests.

The amount was restored, however, through an amendment offered by Rep. Edward Boland (D.-Mass.) by boosting the $300 million recommended for research and development for Fiscal 1960 to $318.6 million. This was possible because Congress, under the Fiscal 1960 authorization bill, had approved a maximum of $333 million for research and development.

When Gross raised the second point of order regarding the $22.7 million recommended for construction and equipment under the supplemental, Thomas explained that amount could not be added to $52 million for construction and equipment in Fiscal 1960 since Congress had authorized a maximum of $57.8 million in this category.

Senate action on the measure is expected within the next two weeks.



Plant Produces Liquid Hydrogen for Advanced Rocket Engines

Liquid hydrogen for advanced rocket engines is produced in tonnage quantities near West Palm Beach, Fla. (AW May 18, p. 38). Hydrogen source is crude oil and water in form of steam. The gas, after purification and catalytic transformation from ortho to the more stable para form, is liquefied in the compressor building (foreground) and stored at —423F. Plant, operated by Air Products, Inc., is near the Pratt & Whitney facility developing the liquid hydrogen propellant Convair Centaur second-stage engine (see p. 81).

The logistics of LOX

Liquid oxygen is being loaded into these tank trailers right from an Air Products generating facility . . . *and in a matter of minutes it will arrive at an adjacent missile test site.* This will happen again tomorrow, the next day, next week—whenever LOX is needed. Each time it happens, valuable time will be saved.

The LOX will get to the test site purer too . . . because on-site generation eliminates the possibility of contamination from intermediate handling and storage.

The same logistics applies to nitrogen and to hydrogen . . . and to argon, acetylene, carbon monoxide and many other vital military and industrial gases. In each case, the key to dependable supply is Air Products on-site generation to serve the needs of a single customer. There's no "overland" hauling, no waiting in line.

Air Products skilled team of engineers, chemists, physicists and designers . . . our specialized manufacturing facilities . . . and our valuable experience in supplying all major missile development and test centers . . . are at your command. Your inquiry is invited. Write Air Products, Inc., Allentown, Pa. Phone: EXpress 5-3311.

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Hungarian Suggests Mechta Was Four-Stage, 400-Ton Vehicle

Washington—Further speculation on the configuration and performance of Soviet Russia's Mechta solar-lunar rocket, appearing in the monthly journal of the Hungarian Academy of Sciences, suggests that it was a four-stage vehicle weighing about 400 tons, controlled only by automatic programmers and not from the ground.

Erno Nagy, secretary of the Hungarian Academy, wrote in "Magyar Tudomany" (Vol. 4, No. 3, March, 1959) that "we know that the 2 January 1959 Soviet space rocket was set in its course at an altitude of 1,500 km. (932 mi.) and thus its speed could have been 10,100-10,200 meters per second (33,138-33,466 fps.).

". . . If we hypothesize that a four-stage rocket was used to attain the desired speed (which is logical considering that the intercontinental ballistic rocket is two-stage and that the artificial satellite rockets are three-stage) and if we hypothesize that petroleum-oxygen fuels were used . . . then we can make a fairly

Scale Model Shows Centaur Configuration

Scale model of Centaur shows how Convair Division of General Dynamics Corp. Atlas-D intercontinental ballistic missile will be topped by a Convair upper stage powered by liquid hydrogen, liquid oxygen engines being developed by Pratt & Whitney Aircraft Division of United Aircraft Corp. Mockup of an instrumented satellite vehicle forms nose of model. Atlas-Centaur vehicle would be capable of orbiting 10,000-lb. satellite payloads at 300-mi. altitudes, or 2,500-lb. payloads at 22,000-mi. altitudes, according to Convair.

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VISCOUNT refuels at Tulsa Municipal Airport using Reda Jet-Fuel Submergible Pumps.

REDA **Jet-Fuel** Submergible Pumps Give These Important Advantages:

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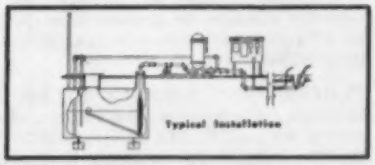
- **High Volume at Required Operating Heads** — Models from 1 to 150 HP — capacities to over 1000 GPM.
- For single or double hydrant systems, tank truck and test stand refueling systems.

Illustrated is a typical Underground Storage and Hydrant Refueling System with Reda Jet-Fuel Submergible Pumps, used by Continental Air Lines. This system uses two storage tanks and two Reda pumps feeding into a filter and hydrant refueling system. *It has proved to be less expensive in both installation and maintenance than a conventional tender system would have been.*



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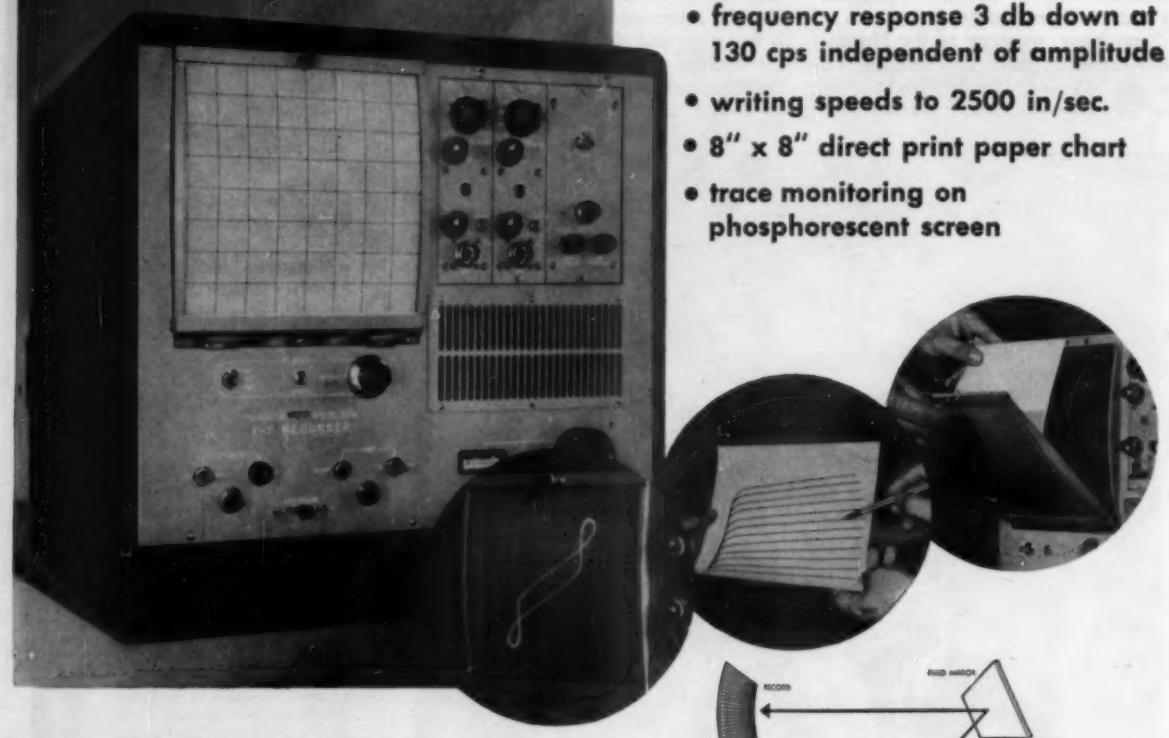
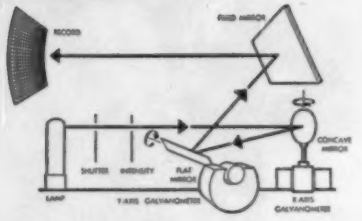
with immediate readout



THE NEW SANBORN MODEL 670 OPTICAL X-Y RECORDER HAS

- 1% linearity
- frequency response 3 db down at 130 cps independent of amplitude
- writing speeds to 2500 in/sec.
- 8" x 8" direct print paper chart
- trace monitoring on phosphorescent screen



X-Y RECORDING never before possible with electro-mechanical instruments can now be done with the new Sanborn Model 670 X-Y Recorder. Direct writing on ultraviolet-sensitive recording paper by a beam deflected by optical galvanometers makes possible the combination of fast writing speed and 130 cps frequency response not found in any other X-Y recorder. Transistor characteristics, acceleration and vibration of mechanical parts and events of similar short duration can be recorded with linearity of *1% of full-scale* and at trace speeds as fast as *2500 inches per second*. Square wave response exhibits no greater than ½% overshoot *at any amplitude;* sensitivities as high as 62.5 uv/inch (depending on preamplifier used).

PLOTS OCCUPY AN 8" x 8" RECORDING AREA and can be previewed or monitored on the instrument's phosphorescent screen. An Axis Record switch to print X and Y axes on the record, and a Beam Intensity Control to assure maximum trace clarity, are among the front panel controls provided. An 8" x 8" sheet of the ultraviolet-sensitive chart paper (stored in drawer at base of cabinet) is easily placed on the back of the hinged screen. Brief post exposure in normal room light is the only developing process.

OPTIONAL INTERCHANGEABLE PREAMPLIFIERS for each axis presently include the Model 850-1300B DC Coupling and Model 850-1200 Phase Sensitive Demodulator; a Carrier Preamplifier, High Gain Preamplifier and a time base generator are now in development. Driver Amplifiers are compact, fully transistorized plug-in units with single-ended input and output. Galvanometers are low resistance, low voltage units of rugged, enclosed construction; sensitivity and damping are independent of coil temperature. Accessible, unitized circuitry also extends to the power supplies—a front-panel plug-in for both preamplifiers and a second supply for both driver amplifiers. A built-in blower provides constant, forced filtered air cooling. The Recorder can be rack mounted in 15¾" of panel space, or housed in its own 20" x 20" x 21¼" optional portable cabinet.

Ask your local Sanborn Sales-Engineering Representative for complete information on the Model 670 X-Y Recorder, or write the Industrial Division in Waltham, Mass.

SANBORN COMPANY

INDUSTRIAL DIVISION
175 WYMAN STREET, WALTHAM 54, MASS

reliable estimate of the rocket's size. We might cite the estimate of W. von Braun, according to which the Soviet space rocket weighed about 400 tons," Nagy wrote.

"And if we also use a recently appearing official photograph as a basis for our analysis, then the following weights can be assumed: first stage, 300 tons; second stage, 75 tons, third stage, 16 tons; and fourth stage, nine tons.

"The burning time of the entire rocket can be put at about 4 min., divided as follows: first stage, 2 min.; second stage, 1 min.; and the third and fourth stages, half a minute each. In all probability the first three stages used liquid fuel (petroleum and liquid oxygen) but the fourth stage could have been solid fuel . . ."

Although Russian announcements shortly after the launching said control of the rocket's flight in latter stages was by radio, Nagy wrote: "At this time we cannot speak of actually remote controlled rockets. All the rockets used so far have had the common characteristic that from the moment of takeoff it was no longer possible to control the movement of the rocket. Built-in and preset programers directed the rocket. The only intervention possible was to blow up the rocket in case of danger."

Nagy also said Mechta used "practically the same system" for data transmission as was used in Sputnik III—"a device which recorded data and transmitted it above the home stations in packets (in response to query signals) by microwaves."

"The first artificial planet and its fourth stage rocket were equipped with shortwave (15 meter) and microwave (1.6 meter) radios," Nagy said. "The shortwave equipment transmitted coded scientific information as in the earlier artificial satellites; the microwave equipment transmitted in response to a terrestrial query signal . . ."

Grand Central To Build NASA Rocket

Redlands, Calif.—A $175,000 contract for development and construction of a prototype solid propellant rocket using an experimental design technique to achieve high mass ratio has been awarded Grand Central Rocket Co. here by National Aeronautics and Space Administration.

If the principle proves out, NASA would presumably have the technique used in a rocket of the size needed for some application. Grand Central engineers think it will probably lead to a medium-size, deep-space terminal stage rocket but hasten to emphasize that the new method is not limited by size, altitude or mission. Present contract extends through test firing of a few

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Solve your engineering problems at desk-side!

With the compact, powerful LGP-30, you don't have to wait in line for the answers you need—because you program and operate this computer *yourself!* What's more, with alphanumeric output and complete format control, the LGP-30 print-out is your final report. There's no deciphering required!

The LGP-30 gives you memory (4096 words) and capacity comparable to computers many times its size and cost—yet is by far the easiest to program in basic machine language. There's no expensive installation or air-conditioning. A library of programs and sub-routines is available—as well as membership in an active users organization. Customer training is free. Service facilities are maintained coast-to-coast.

Among the many important jobs now being assigned to the LGP-30 in the aircraft and missile fields are: wind tunnel and flight test data reduction, guidance system design, transducer calibrations, flutter and vibration studies, propulsion research, trajectory studies, component reliability evaluations, specific impulse calculations, thermal stress distribution. For further information and specifications, write Royal McBee Corporation, Data Processing Division, Port Chester, New York. In Canada: The McBee Company, Ltd., 179 Bartley Drive, Toronto 16.

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Work like this developed the Timken Company's "16-25-6" steel, the steel that helped keep jets flying—now helps get missiles off the ground. For the steels you'll need or the steel problems you may have, call upon our experts for help. They've been developing new steels and solving hundreds of tough steel problems for 30 years. Call or write the leaders in electric furnace fine alloy steel production, The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steels and Removable Rock Bits.

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copies of the test rocket. This is the first direct NASA contract Grand Central has been awarded. The company has a subcontract from McDonnell Aircraft Corp. for development of the escape rocket in Project Mercury. The new contract was awarded in response to an unsolicited proposal by Grand Central.

The experimental rocket is the outgrowth of designs by Grand Central engineer Ralph M. Pierce. NASA is withholding details of the design approach but it is described as a method of holding down non-grain motor weight which involves no manufacturing innovations.

Satellite Telescope Considered for Orbit

Washington—Studies leading to mounting of a large telescope in an earth satellite will be undertaken by Kitt Peak National Observatory, near Tucson, Ariz., under a $160,000 grant made recently by National Science Foundation.

The telescope probably will have a 50-in. aperture and will function for five to 10 years. NSF spokesman said lack of atmospheric disturbances at orbit altitude should enable the telescope to view plants or distant stars with "unprecedented clarity."

Observations would be sent to earth stations by a television link or some other suitable radio channel. Orbit would be "several thousand miles" above the earth's surface.

The study, under direction of Dr. Aden B. Meinel, observatory director, is being made in cooperation with National Aeronautics and Space Administration.

Preliminary work in this field has been accomplished by Naval Research Laboratory rocket observations and by Princeton University balloon-borne telescope observations.

Ultraviolet Space Telescope Studied

Washington—Contracts for design studies for an ultraviolet telescope system that will be orbited in a space observatory and a study that will permit redetermination of the Astronomical Unit have been awarded by National Aeronautics and Space Administration.

University of Wisconsin will do the telescope study on a $60,000 contract. The telescope will be used to examine stellar radiation. Yale University, under a $110,000 contract, will use a radio telescope to measure the doppler effect of the 21 cm. hydrogen line resulting from the orbit of the earth around the sun, in an effort to determine more pre-

THE GRAND CENTRAL REPORT

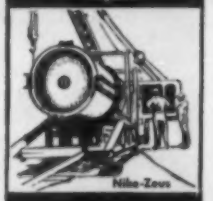
Mercury

Terminal Stage, NASA

Explorer III and IV

Far Side

Vanguard


Nike-Zeus

Test Sled

Since merging with Food Machinery and Chemical Corp. and Tennessee Gas Transmission Co. a year ago, Grand Central Rocket Co. has developed an organization of highly competent management and efficient modern facilities. FMC and TGT have set as their goal building GCR into one of the strongest, most capable solid propulsion organizations in the country.

With over 500 employees, this seven year old organization (a veteran in this business) has some 200 engineers and scientists with an average of over eight years of experience in solids.

This able group has been augmented with the addition of Mr. John J. Crowley, former director of the Office of Guided Missiles, Dept. of Defense, as Vice Pres. for Project Management and Marketing; Mr. Gerald Makepeace, technical director of propulsion for Polaris, as Vice Pres. for Research and Engineering; Mr. Albert T. Camp, formerly Head of the Propellants Division, NOTS, as Asst. Vice Pres. and Dir. of Research; Mr. G. Daniel Brewer, of the Minuteman missile program, Space Technology Labs, as assistant to Mr. Crowley; Mr. George Cushman, former staff specialist in the Office of the Dir. of Guided Missiles, as Dir. of Marketing, and others.

At this moment the Company has an *excess* capacity of over 500,000 lbs. of propellant a month to place at the disposal of the Nation's rocket program.

GCR now has the *know-how, men, facilities, financial background,* and the *management capability* to undertake successfully any solid propulsion development and production foreseeable in the Nation's military and space program.

It has a planned standby available *now*—a strong complement of engineers, scientists and support personnel to undertake these programs at once. They are now engaged in company sponsored work on propellants, thrust control, and reliability assurance to advance our knowledge and be ready with new and valuable ideas when called upon. They will not have to be taken off other important projects.

If you have an application requiring a seasoned team of men and facilities to counsel you, to participate in your advanced concept studies, or to start immediately on a new development, contact GCR for a prompt response.

Cledo Brunetti

Cledo Brunetti
Vice President and General Manager

(If you have the qualifications that a fast-moving space propulsion team needs, contact our Director, Personnel. Openings now for chemists and engineers.)

Grand Central Rocket Co.

An Affiliate of Tennessee Gas Transmission Company
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This is the symbol of Aerotest's new Product Engineering Division. It stands for the same high level of service and creative engineering that has earned for Aerotest's Test Engineering Division a reputation as the leading independent test laboratory serving the aircraft and missile industry.

Major expansion of Aerotest's Product Engineering Division solves a serious problem faced by Weapon System contractors

THE PROBLEM: Increasing scope and complexity of aircraft, missile and spacecraft Weapon Systems has made it virtually impossible for contractors to locate and purchase "standard, readily available" equipment which meets their requirements. The problem is heightened by the fact that most equipment suppliers are often unwilling or unable to undertake programs that do not fit into their "standard" line of products.

As a result, contractors are forced into producing equipment at their own plants to satisfy their own needs. This means a considerable loss in efficiency plus higher costs, since the "special" project is often incompatible with the contractor's field of endeavor.

THE SOLUTION: The PRODUCT ENGINEERING DIVISION of Aerotest Laboratories, Inc. provides a proven solution. Aerotest's PED does not maintain or depend on a "standard" line of products. Instead, it offers an integrated team of Design and Production Engineers, supported by modern manufacturing facilities—available to assist you with your "special" equipment requirements, in limited or large production quantities.

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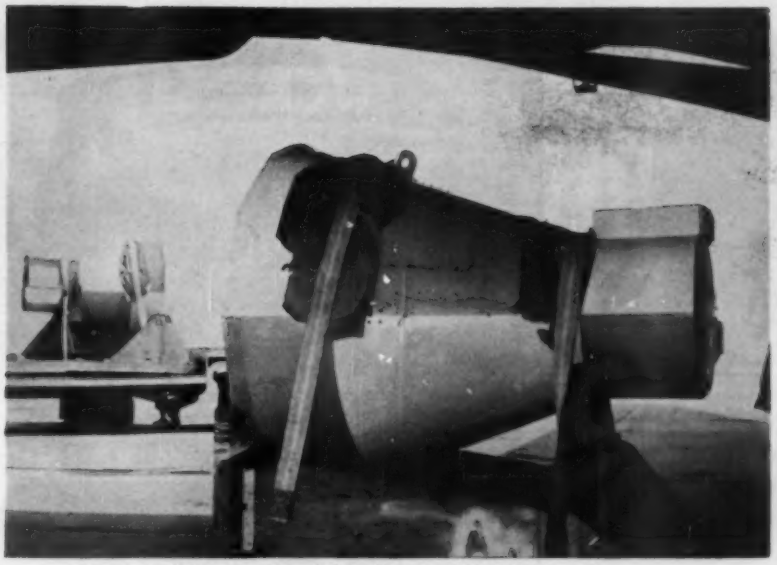


Mercury Mockups Delivered

Two full scale mockups of the Project Mercury capsule being developed by McDonnell Aircraft Corp. are delivered to Northrop's Radioplane Division. They will be fitted with parachute landing systems being developed by Radioplane's Paradynamics group (AW Apr. 27, p. 114) and taken to El Centro, Calif., for drop tests over the Salton Sea.

cisely the distance from earth to sun.

Army Ballistic Missile Agency, under a $1 million contract, will conduct advanced research into propulsion and propellants; guidance studies involving celestial mechanics of lunar and interplanetary trajectories; thermal properties of materials in space re-entry, and effects of space environment on physical and chemical properties.

Other NASA contracts awarded in May include:

• **Convair's Astronautics Division**–$7.5 million as initial funding for eight two-stage Vega vehicles and another for captive firing tests (AW May 11, p. 34).

• **Jet Propulsion Laboratory**–$5 million initial funding for technical supervision, mission planning and third stage development for Vega.

• **USAF Ballistic Missile Division**–$4.4 million for Thor Able and Atlas Able space probes authorized earlier. Another $16 million had been awarded previously.

• **Navy Bureau of Ordnance**–$180,000 for 16 Allegany Ballistic Laboratory third-stage Delta rocket motors, 12 of them for Delta vehicles (AW May 4, p. 37) and four to be mounted on top of Sergeant rockets for high-altitude firings from Wallops Island, Va., to check out ejection and inflation of a 100-ft. inflatable sphere which will be used as a passive communications satellite.

• **Jet Propulsion Laboratory**–$110,000 for transmitter for the Goldstone, Calif., tracking installation as part of a passive communications satellite project (see above).

• **Army Surgeon General's Office**–$150,000 for medical work on the Jupiter shot which carried monkeys Able and Baker.

• **National Academy of Sciences**–$350,000 for graduate and post-doctorate research study grants, with associates selected by the academy to work at NASA's Goddard Space Flight Center.

• **National Science Foundation**–$110,000 to support the Space Science Board.

• **University of Florida**–$60,000 for study of general instability of cylindrical shells, aimed at aiding rocket and space vehicle designers.

• **California Institute of Technology**–$110,000 for basic studies of cylindrical and conical shells.

• **New York University**–$120,000 for study of general instability of stiffened circular cylinders.

• **Army Ordnance Corps**–$50,000 for part of 30 Nike Asp sounding rockets to be fired to 150 mi. carrying 50 lb. payloads for ionospheric sampling. Shots will be from Ft. Churchill, Canada, and Wallops Island, Va.

• **Aerojet-General Corp.**–$660,000 for 20 Aerobee Junior and Aerobee-Hi sounding rockets for shots from Ft. Churchill and Wallops for ionospheric investigations, carrying 150 lb. to 150 mi. altitude.

• **Army Ordnance Missile Command**–$560,000 for multi-frequency radio beacons to be used in satellite investigations of ionosphere.

• **Jet Propulsion Laboratory**–$300,000 research and development on improved tracking and receiving equipment for deep space missions.

• **Massachusetts Institute of Technology**–$200,000 to assist NASA in making technical evaluations of facilities and instrumentation in the Project Mercury tracking network.

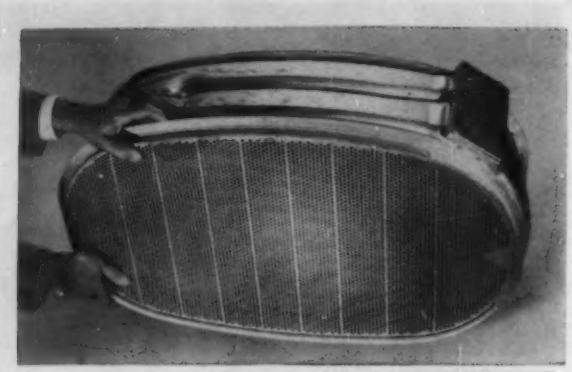
Two Stations to Track, Predict Satellite Orbits

Defense Department will set up two new space-vehicle tracking data-acquisition stations at New Boston, N. H., and Donnelly Flats, near Fairbanks, Alaska, to track and predict orbits of satellites and to receive telemetry data. The New Boston station will be built by Davison Construction Co., Manchester, N. H. The Ralph M. Parsons Co., Los Angeles, will build the Alaska facility.

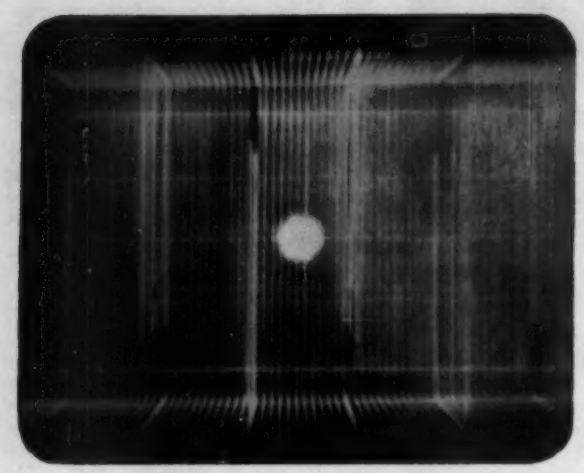
Mirage 3 Armament Displayed

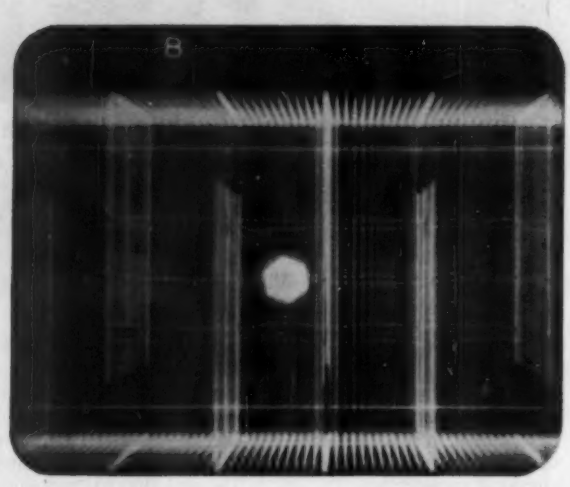
Armament for Dassault Mirage 3B trainer, shown here on the company's stand at the 23rd International Aeronautical Salon at Le Bourget, features a Nord 5103 air-to-air missile mounted under the belly and unguided-rocket pods mounted under the wings. Pods were developed by Dassault, and combine rocket armament installation with an external fuel tank. Sliding band seen just ahead of mounting pylon moves forward to expose vents for rocket exhaust.

An oil cooler as it comes from the airplane engine. Radiograph below shows accumulations of sludge and dirt on the tubes.



After cleaning, the oil cooler is ready to return to its job. Radiograph below shows dirt gone and passages unrestricted.





To keep an engine's bloodstream clean

Oil coolers are vital to today's aircraft engines. At overhaul time they must go back on the engine clean as new. No minute particles of carbon or metal can remain to be a threat to the renewed engine. Cleaning them has become a specialty with SMS Instrument and Accessories Corp. of Idlewild Airport, N. Y. C.

To show that each cooler they clean is free of debris, it is sent to Industrial X-ray Incorporated, New Hyde Park, New York, to be radiographed. And when the cooler goes back to its job, its x-ray certificate of cleanliness goes with it.

In such inspections of assemblies, in quality control, in nondestructive testing, radiography provides a means of "seeing" internal conditions and also a lasting record of what is seen.

Producers of castings, and makers of welded products, find radiography a means of expanding their business and making sure only high-quality work is delivered.

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ARPA Studies Auxiliary Space Power

By Philip J. Klass

Washington—A multitude of different techniques for generating electric power, many of them previously considered impractical laboratory curiosities, now are under active investigation by a variety of companies for possible use in space vehicles and satellites.

The Advanced Research Projects Agency is sponsoring about 20 exploratory research or development programs with Fiscal 1959 funds.

These investigations are spurred by the need of space vehicles for compact, lightweight, long-lived electric power sources, and by recently gained knowledge in the fields of semiconductors and high temperature materials. Many of the programs are sponsored by the Defense Department or National Aeronautics and Space Administration, but a number are being financed with company funds.

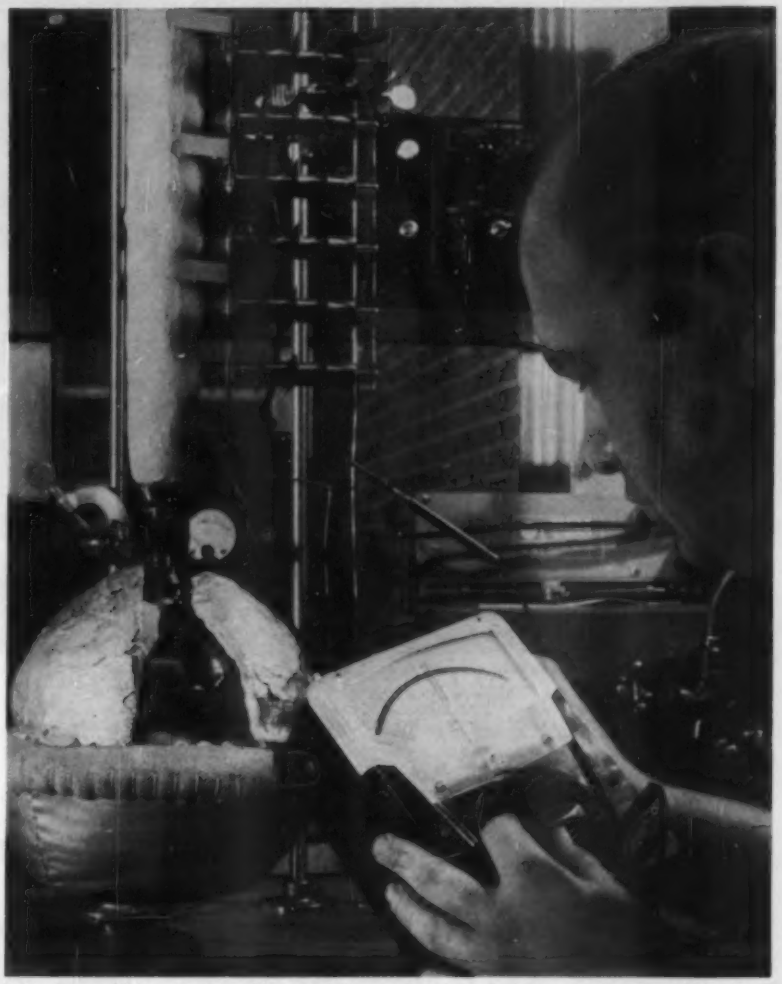
As might be expected, companies like General Electric and Westinghouse which got their start in electric power generation are extremely active in the field, as are companies like Union Carbide Corp., an old-timer in electric batteries.

Newcomers in Field

But there are many newcomers, with a variety of industrial backgrounds, according to Dr. N. W. Snyder, head of Nuclear and Space Power in the Advanced Research Projects Agency. For example:

- **Lockheed Aircraft** has a sizable group of scientists working on fuel cells. Martin is working on thermonuclear power packages, such as its SNAP III.
- **Allison Division of General Motors** is investigating application of the Stirling heat engine, originally invented more than 100 years ago (AW June 22, p. 225).
- **Hoffman Electronics** and Texas Instruments are among the avionic companies working on solar cells.
- **Electro-Optical Systems, Inc.**, recently formed research group in Pasadena, Calif., is investigating techniques for new semiconductor alloys with greatly increased efficiency for converting solar energy into electricity.
- **Merck**, a pharmaceutical house, is producing thermoelectric materials such as bismuth telluride and is developing improved semiconductor materials for this purpose.

The foregoing is far from a complete list of companies now actively investigating new power sources and conversion techniques. It is intended only to indicate the broad spectrum of company backgrounds now being applied to the problem.



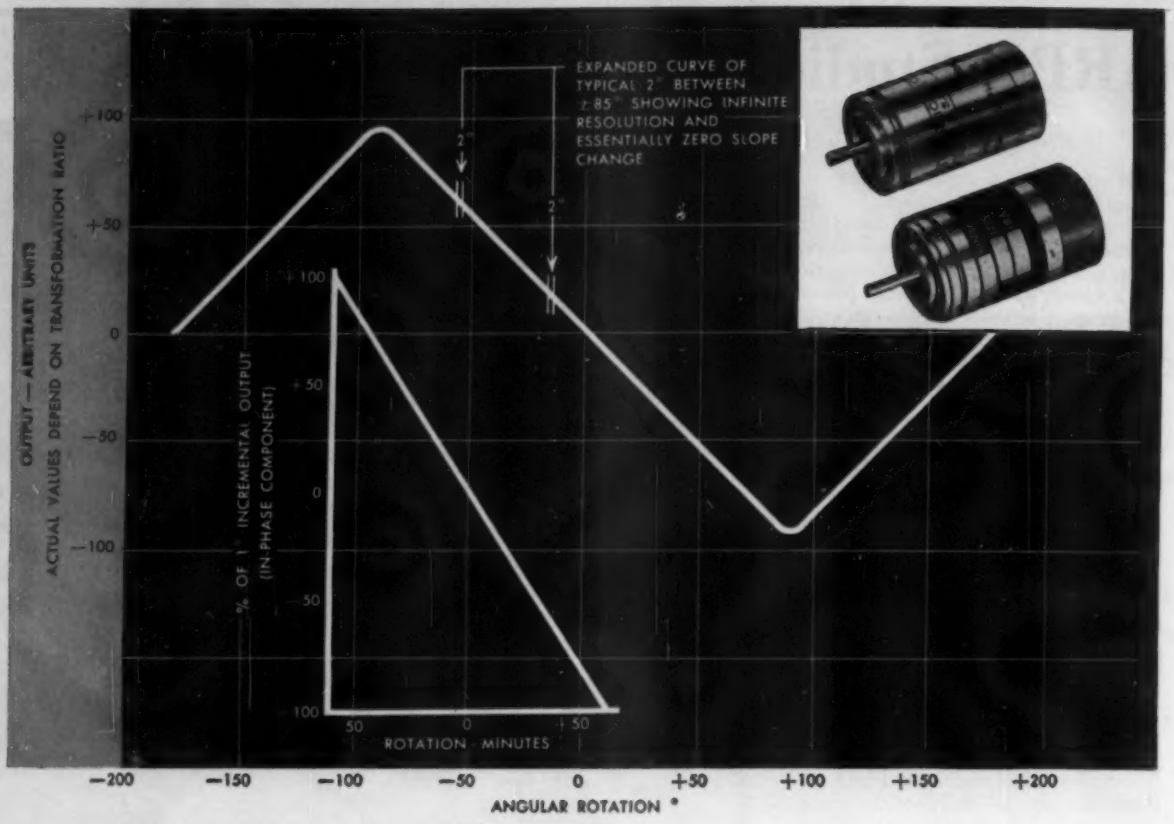
SIX pieces of bismuth telluride, active thermoelectric material, protrude about ½ in. from heat transfer columa, followed by cooling fins on the cold side of the junction, in Merck Sharp & Dohme Research Laboratories Physical Science Group experimental power generator. Heat source for the hot junctions is refluxing vapor of dichlorbenzene.

Fresh Look

The size, weight and reliability requirements imposed by satellites and space vehicles has forced scientists to take a fresh look at the problem of generating electric power, starting with such basic factors as energy sources, conversion techniques and storage mechanisms.

A variety of different electric power systems for space vehicles can be synthesized. Some of the more promising possibilities, cited by Dr. Snyder at a recent annual Power Sources Conference in Atlantic City, N. J., sponsored by Army Signal Research and Development Laboratories, include the following:

- **Solar photovoltaic:** Silicon solar cells are popular sources for space power because they are simple to use, reliable and long-lived. However, they are expensive to produce. This fact, together with their modest 10% conversion efficiency, makes them a costly source for sizable amounts of power. For example,



Inductive pots give accurate noiseless output with infinite resolution

Weapons systems . . . analog computers . . . proportioning circuits—wherever the limitations of wirewound potentiometers can not be tolerated, these precision linear pots are the answer.

The Daystrom Transicoil Size 8 and 11 Inductive Pots provide extreme angular accuracy for applications requiring linear output and high gain amplification. There are no brushes wiping over turns of resistance wire to generate noise. Grounding problems are eliminated since each phase is electrically insulated from the other. When operated into the correct load, output is linear to within ±0.25% over the 170° (±85° from null) operating range. Output phase is dependent on direction of shaft displacement from null.

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TYPICAL CHARACTERISTICS

	Size 8		Size 11		
Volts	26	26	26	26	115
Excitation Power (watts)	.16	.16	.15	.15	.45
Excitation Current (ma)	27	27	30	30	24
Excitation Frequency (cps)	400	400	400	400	400
Sensitivity (v/°)	.107	.346	.107	.346	.620
Null Volts (mv)	7	20	7	20	40
Transformation Ratio	.350	1.130	.350	1.130	.458

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cost of silicon cells required to produce 200 watts of power runs a minimum of $100,000, or as high as $600,000 if cells are not automatically oriented to always face the sun, according to Dr. Snyder. Recent research has suggested the possibility of using combinations of different semiconductor materials which are sensitive to solar radiation over a much wider portion of the spectrum than a single semiconductor-like silicon. Such techniques, when developed, may permit solar cells with conversion efficiencies of as much as 35%.

• **Solar thermoelectric,** solar thermionic system: Such systems will employ large solar mirrors for concentrating energy on the surface of the thermoelectric or thermionic material. To maintain adequate temperature differential between hot and cold junctions of a thermoelectric converter, or the anode and cathode of a thermionic converter, without requiring a large radiator surface, will require the cold elements to operate at temperatures of approximately 200C to 300C. Considerable research is needed to develop suitable materials which can operate for extended periods at such temperatures. Another area that requires development is the design of large energy collectors and associated controls for keeping them aligned with respect to the sun and the thermoelectric/thermionic converter.

• **Solar dynamic engine:** Heat from a solar energy concentrator can be used to operate a small turbine or a reciprocating engine, such as the Stirling, to drive a generator. Use of rotating machinery will pose problems in reliability where long operating life is required, Dr. Snyder says.

• **Solar photo-emission system:** Photons from solar radiation striking photo-emissive material cause it to release electrons which are collected by a nearby anode. Although present photo-emissive materials have lower conversion efficiency than silicon cells, they are only a fraction as costly as silicon cells. Dr. Snyder envisions a "carpet" coated with photo-emissive material which might be unfurled from a space vehicle once in space or orbit.

• **Solar regenerative fuel cell:** Solar energy can be used to disassociate two chemicals by means of heat or proton energy. As the two chemicals pass through a fuel cell, they recombine to produce electric power. Considerable research is needed to devise regenerative chemicals which can perform efficiently, Dr. Snyder says.

• **Nuclear thermoelectric system:** The thermoelectric material can be integral with the nuclear fuel elements or external to the core. However, little is known at present about the effects of nuclear radiation on the lifetime of thermoelectric materials. To achieve high efficiencies, the hot side of the thermoelectric material should be operated at temperatures of at least 1,200C, Dr. Snyder believes, which poses an additional materials research problem.

• **Radioisotope thermoelectric/thermionic/dynamic engine system:** Radioisotopes as a source of thermal energy are attractive where power source lifetime is not too long. However, because of decay in radioisotope energy level, excess capacity must be carried during initial part of the mission and the excess energy must be dissipated. Radioisotopes with useful half-life are extremely expensive. Cerium 144, for instance, with a half life of 290 days in sufficient quantity to generate 200 w. power, currently costs several hundred thousand dollars, according to Dr. Snyder. However, the price of radioisotopes is expected to come down by a factor of four or five to one. If the isotope produces gamma radiation, this raises shielding problems for other equipment aboard the space vehicle.

Based on present technology, Dr.

Space Power Requirements*

Mission	Capacity	Lifetime
Scientific satellite	50 w.–5 kw.	hours–1 yr.
Navigation satellite	100 w.–30 kw.	1–5 yr.
Meteorological satellite	100 w.–30 kw.	1–5 yr.
Communication satellite	100 w.–300 kw.	½–3 yr.
Space station	3 kw.–20 megawatts	2–10 yr.
Manned satellites, maneuverable vehicles	500 w.–20 megawatts	hours–1 yr.
Propulsion	1 kw.–20 megawatts	½–2 yr.

*Based on report by Dr. N. W. Snyder, ARPA

Possible Energy Sources for Space Vehicles

Solar Energy:		
	Thermal:	Radiant energy from sun is absorbed and converted into heat for operating turbine or piston engine, thermoelectric device or thermally regenerative fuel cell.
	Photons:	Quantum energy of photons in solar radiation ejects electrons from atomic structure of material in what is broadly called "photoelectric effect." Photon quantum energy also can be used to dissociate chemicals for use in fuel cells.
Chemical Energy:		
	Galvanic battery:	Device is reliable source of electric power, providing temperature does not vary widely, and also serves as a power storage device. However, present batteries are relatively large, heavy for org lifetimes and high discharge rates.
	Regenerative chemical:	Employed in cyclic process such as a closed-loop fuel cell in which chemical process that takes place in fuel cell subsequently is reversed by means of radiation from the sun, or from a nuclear source.
	Chemical fuel:	Combustion of fuel to provide heat for conversion to electricity. Size and weight of fuel and its containers make this of doubtful value for long-lived space missions.
Nuclear Energy:		
	Radioisotopes:	These byproducts of nuclear fission normally are employed as a source of heat. However, they might also serve as an ionization mechanism, although this has not been successfully applied to a power generating device.
	Nuclear fission:	Nuclear reactor normally serves as a source of heat, but conceivably its fission fragments and beta particles might be used for direct conversion to electric power.
	Nuclear fusion:	Controlled fusion power, if it proves feasible, appears to be many years away for space vehicle use.
	Plasma magneto-hydrodynamics:	Use of a fissionable gas carrying a traversing shock wave which becomes critical at either end of a closed tube, with electric coupling between plasma and external coil used to generate electricity directly has recently been suggested. However, much additional research and development will be required to establish feasibility.

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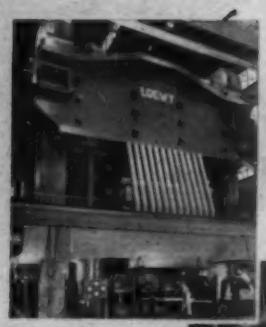
crack an egg or shape a missile

100,000,000 lbs. of pressure—so delicately controlled that it can be made to crack the shell of an egg. Use the fabulous forces of present day forging skills to crack the barriers of space—weight, strength, high temperatures. Forge the future, today



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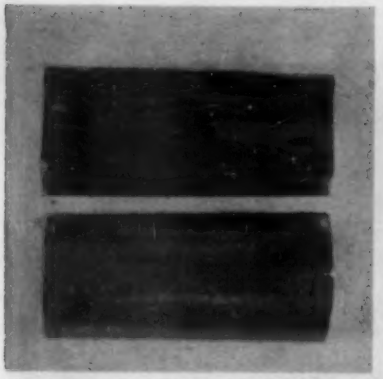


INGOT of Merck bismuth telluride, the active material used in a variety of thermoelectric power and cooling apparatus, is split lengthwise to show oriented layer structure.

Snyder believes that space vehicle power sources will weigh in with approximately the following output power-to-weight ratios:

- Less than 1 kw.: 100 to 1,000 lb./kw.
- 2-5 kw.: 50 to 300 lb./kw.
- 10 kw.: 20 to 150 lb./kw.
- 100 kw.: to 50 lb./kw.
- 2,000 kw. and above: 3 to 10 lb./kw.

Although present space vehicles are being designed to operate with electric power sources of only a few kilowatts or less, ARPA's immediate future objective is to develop power sources capable of developing 25 to 30 kw., Dr. Snyder says. The agency is studying systems with up to 20,000 kw. capacity, he adds.

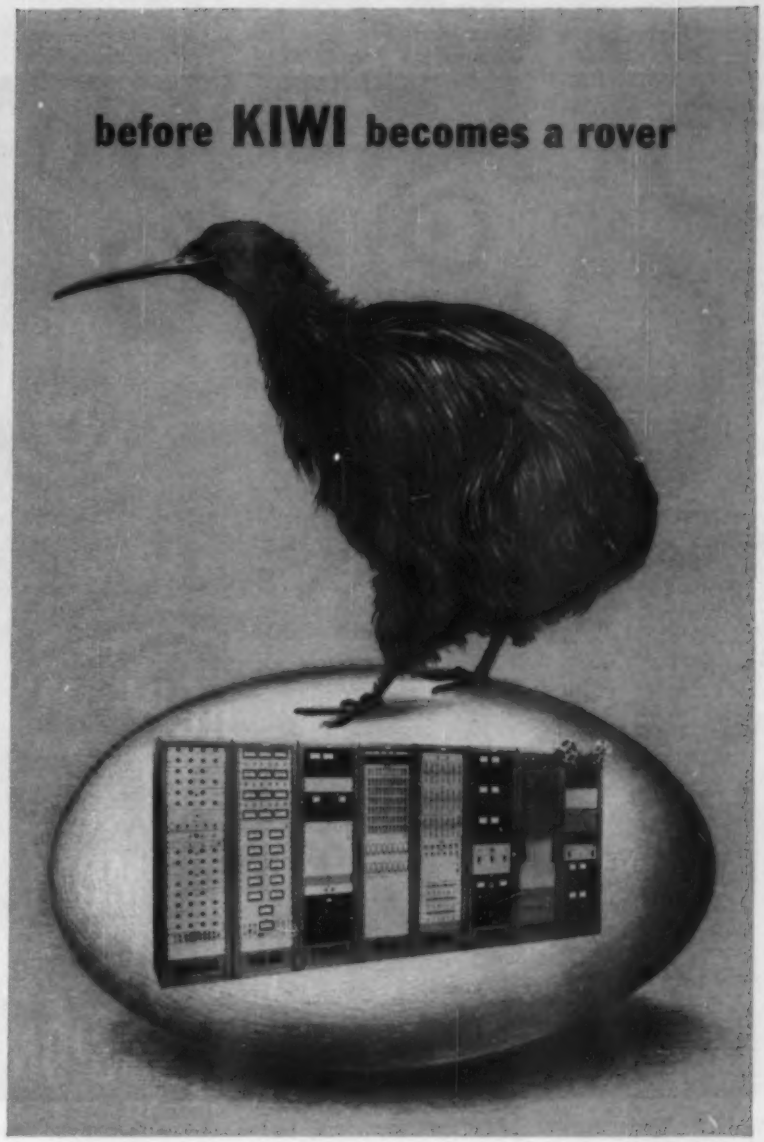
Power systems required for currently programed space vehicles are being developed directly by or under the guidance of the military service or vehicle contractor involved.

Exploratory Research

Exploratory research aimed at developing the techniques and materials required for subsequent generations of space vehicles is being sponsored by ARPA, the National Aeronautics and Space Administration, and by the Atomic Energy Commission which is responsible for nuclear powerplants.

To avoid unnecessary duplication of effort, to explore all promising areas and to keep all interested groups advised of progress in the field, a coordinating group on flight power has been formed recently, with representatives from ARPA, NASA, AEC and each of the three services. Within this framework, the committee has set up subgroups. One, for example, specializes in nuclear powerplants and another in solar energy power systems.

ARPA currently has approximately 20 research and exploratory development programs under way or in the process of being made final with the approximately $2½ million of Fiscal



Project Rover is aimed at developing a nuclear-powered rocket engine that will result in man's conquest of intergalactic space. Kiwi-A is its first land-based test reactor, named for the flightless New Zealand bird.

Before Kiwi becomes a space rover, an immense amount of test information will be needed. Edgerton, Germeshausen & Grier, Inc., is cooperating with the AEC, NASA and Los Alamos Scientific Laboratory in collection of this vital data.

For Project Rover, EG&G has designed, built and is now operating an 800-channel control and instrumentation system yielding diagnostic information for designers of tomorrow's spacecraft.

Thus, Edgerton, Germeshausen & Grier, Inc. again is applying its unique operating, design and manufacturing experience to help advance the nation's nuclear weapon, missile and space programs.

Scientific and engineering positions, in physics and electronics are available. Additional information will be furnished upon request.

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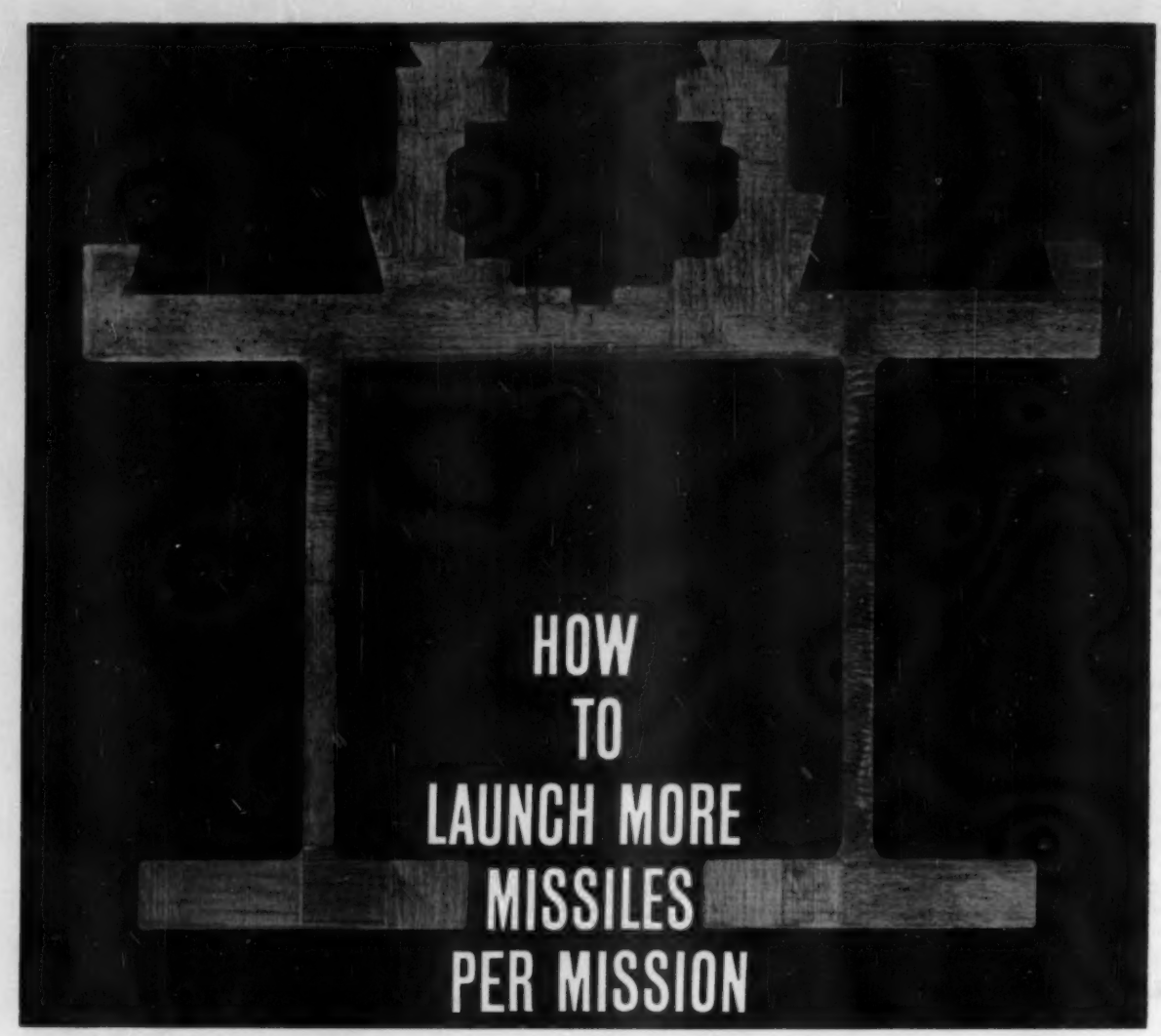

Terrier missiles already are operational on the cruisers *Boston* and *Canberra*, and on the destroyer *Gyatt:* facilities for carrying them will shortly be added to three other vessels by the U.S. Naval Gun Factory. This cross section of Alcoa Aluminum is part of the storage and handling tracks that store and deliver the missiles to the launcher

NEW TERRIER surface-to-air missiles have vastly lengthened the reach of the Navy's antiaircraft arm.

THE NUMBER of these missiles carried on an operational U.S. ship is classified. So is the length of time it takes to bring one up from its storage racks and send it winging on its way.

THIS MUCH can be said: Thanks to the ingenuity of the U.S. Naval Gun Factory, with an assist from Alcoa® Aluminum, the storage and handling track permits launching a missile in a gratifyingly *short* space of time. And, thanks to the *lightness* of Alcoa Aluminum extruded forms, weight savings on the launching and handling facilities permit carrying at least *eight* extra missiles on every mission.

CONSIDER the storage and launching tracks, for instance—shown in cross section above. More than 1⅓ miles of this track is housed on the deck of every Terrier-carrying ship. With steel, the weight alone would be prohibitive. Extruded almost in finished form in Alcoa Aluminum, not only weight but machining costs are kept to a minimum.

ALL CREDIT goes to the men of the U.S. Naval Gun Factory for their skillful design. We'd like to take a small bow ourselves for Alcoa's supporting role. Perhaps there's some similar way in which we might lend assistance to *your* organization. If so, please let us know. Write Aluminum Company of America, 2026-G Alcoa Building, Pittsburgh 19, Pa.

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1959 funds allotted for space power. Snyder is hopeful that Fiscal 1960 funds will permit an expansion of this program. ARPA-sponsored programs are contracted for and monitored by individual services. Agencies involved include: Army Signal Research and Development Laboratory, Army Ballistic Missile Agency, Wright Air Development Center, Air Force Cambridge Research Center, Office of Naval Research and Navy Bureau of Ships.

Here are some of the areas which ARPA is exploring with its current funds:

- **New thermoelectric materials** and their basic physics.
- **Thermionic principles,** including materials and design geometry.
- **Regenerative fuel cell** research, with regeneration by electrolysis, heat and protons. Object is to develop new fuel cell chemicals, determine how they react with electrodes.
- **Solar cell materials** research and development. Another objective is to develop techniques for reducing cost of producing silicon cells as well as increasing their conversion efficiency.
- **Solar dynamic engine** exploratory development. Present plan is to investigate feasibility of using Stirling engine and a small turbine generator, each to be powered by solar heat energy.
- **Basic research in heat radiation** principles. One objective of this program includes determination of how vapors condense when in a gravityless field. Another objective is to investigate possible techniques for obtaining a high emissivity in the infrared region to get rid of internal vehicle heat with low emissivity in the visible light region to minimize solar heating.

Dr. Snyder believes there is no single "best approach" for space vehicle power sources. The choice of techniques depends upon the power required, lifetime needed, and the current state of the art at the time the device is required.

Until such time as the launching of a space vehicle is as safe and certain as the takeoff of an airplane, nuclear power sources may be at a disadvantage because of the extra shielding required to prevent the nuclear fuel from being dispersed over an inhabited area by a rocket engine explosion or other malfunction. Additional shielding will be required to protect personnel during launch and space vehicle avionic equipment from nuclear radiation.

Despite the variety of technical possibilities, the problem of designing compact, reliable power systems with even

Energy Conversion Techniques for Space Vehicles

Thermal:		
	Thermoelectric:	Development of a voltage due to difference in temperature between two junctions of dissimilar materials based on Seebeck Effect, discovered in 1821, and used in thermocouples. Vigorous program of research in thermoelectric materials is under way in U.S. and USSR. For efficient operation in space vehicles, cold junction must operate at temperatures of around 500-600 Kelvin.
	Thermionic:	Generation of electricity through heating to cause emission of electrons. Research and development in high temperature materials suitable for thermionic power devices has been actively pursued only comparatively recently.
	Dynamic heat engines:	Turbines or piston engines, such as the Stirling engine, which can be operated in open or closed cycle.
	Pyro-electric:	Generation of electric potential between two faces of an oriented crystal when subjected to heating, or to electromagnetic radiation in the infrared spectrum.
Photons:		
	Photovoltaic cell:	Photon bombardment causes electron movement within a semiconductor material, producing a voltage across its junction. Silicon cells, most commonly used at present, have conversion efficiency of about 10%, but theoretical efficiency is about 19%. Newer alloy semiconductors in combination may provide conversion efficiencies up to 35% but research is needed.
	Photoelectric emission:	Photon bombardment causes electrons to be ejected from surface of material and to be collected by nearby anode surface. Technique, recently demonstrated by Westinghouse Electric, is less costly than photoelectric cells, but also has somewhat lower conversion efficiency.
Chemical:		
	Fuel cell:	Two chemicals, such as hydrogen and oxygen, are passed through fuel cell where they combine and release electrons. In a regenerative fuel cell solar or nuclear radiation would be used to decompose resultant chemical into original constituents.
	Galvanic battery:	Familiar wet/dry cells convert chemical energy into electrical energy. Increased research may permit battery with combination of high discharge rate and long-cycle life.

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In the event of attack... we cannot expect more than minutes warning and minutes to retaliate. Heretofore ... inertial systems in air-launched missiles required as much as thirty minutes warm up time before operation and an additional amount of time before achieving specified accuracy. The new G.E. Platform is designed specifically to give satisfactory performance over a wide range of temperatures in high G environments.

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More complete details are available on the system by contacting Manager–Control Sales, General Electric Company, Light Military Electronics Department, Armament and Control Section, Johnson City, N. Y., Dept. 12A.

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moderate power capacity for space vehicles is a formidable one, Dr. Snyder concedes. However, the challenge of the problem has stimulated keen interest in the scientific community and within industry. From this activity may come new high temperature materials with higher conversion efficiencies which could have a major impact on power generation techniques for conventional uses.

Missile Miss-Distance Unit Weighs 16 lb.

Los Angeles—Proximity fuzed, nuclear-warhead, air-to-air or ground-to-air missiles can be tested under actual flight conditions without alteration to the missile itself through use of a newly developed Direct Readout Miss Distance Indicator (DROMDI). System, weighing 16 lb. and requiring 600 cu. in. of space, is designed to be carried entirely within the target drone and to function without requiring transponders or other beacons on the missile.

The miss-distance system will cost about $2,000 and can be used repeatedly, depending on safe recovery of the drone, according to Electronic Specialty Co., Los Angeles. Functional capability extends to altitudes up to 100,000 ft. at closing speeds from zero to Mach 10. Near-miss range of 1,000 ft. is normally used and the system will give instantaneous information to the ground when a missile comes to within a scoring range of 1,000 ft.

System configuration is essentially an

Satellite Light-Sensor

Silicon crystal slice held with tweezers can be used as a light-sensing device for satellite telemetry systems. It will perform all functions of its transistorized-oscillator counterpart, components of which are below. Unit was produced at the Westinghouse solid state advanced development laboratory.

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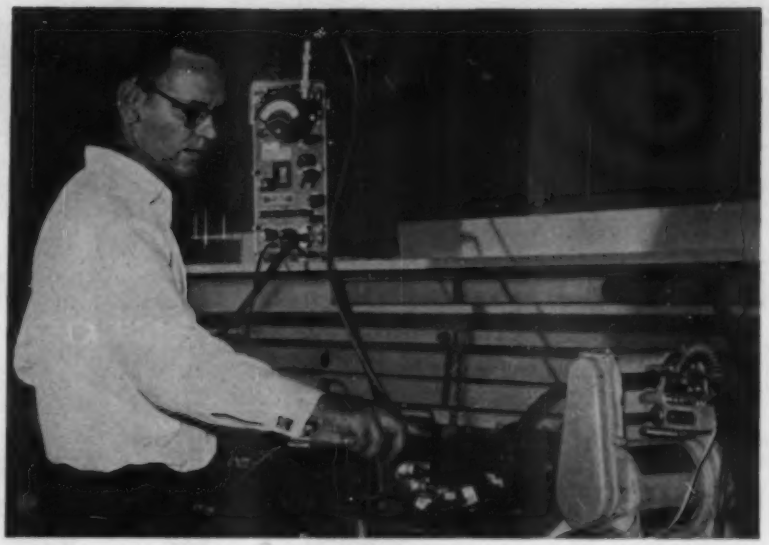

A technician probes radiated interference from an aircraft hoist in the Los Angeles laboratory of Sprague's Interference Control Field Service Dept.

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Once the equipment reaches the prototype stage, Sprague specialists will conduct tests either in the manufacturer's own plant or in one of Sprague's interference laboratories. Sprague will also direct compatibility tests on end equipment or complete weapons systems, and recommend solutions to any integration problems which might develop.

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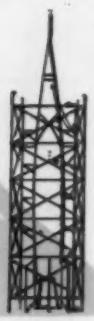

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FMCW radar with the exception that receiver output is fed back into a sawtooth generator for continued adjustment of the transmitter sweep frequency. This solves the problem of obtaining a wide dynamic scoring range since sweep period is directly related to miss distance and can be read out directly and instantaneously at a ground station.

In operation, part of the FMCW output is fed directly to the drone's receiver antenna but most of the output is radiated from the transmitter. Drone antenna therefore receives two signals at a slightly different frequency because of the time delay in the reflected signal and this frequency difference governs the slope of the sawtooth waveform pattern. As the missile approaches the drone, the delay period decreases and output from a discriminator is fed to the sawtooth generator causing it to vary the sweep at a constant frequency deviation. For 1,000 ft. range at its operating frequency, 8 kc./s is selected as the frequency difference, and when the deviation is least, the missile has made its closest approach to the drone. Ground station receiver, tuned to the DROMDI frequency, receives the signal and notes its in range time. The system's transmitter has 100 w. power, giving about 100-mi. line-of-sight range.

Videcon Tube

Extremely sensitive videcon tube, Type WL-7325, reportedly can produce satisfactory pictures with illumination as low as 0.1 foot-candle on its faceplate and can provide resolution equivalent to 600 television lines. Tube is available from Westinghouse Electric, Electronic Tube Division, Elmira, N. Y.

Expansions, Changes In Avionics Industry

Radiation Engineered Services is name of new company which will offer series of training programs in the nuclear field. First of the programs, on isotope radiography, will run Aug. 10-14, followed by other courses on health physics, basic nucleonics, applied nucleonics and other related subjects. Fee for one-week program is $150, or $300 for two-week courses. Company's address is Lafayette and Water Streets, Norristown, Pa. Other announced changes, mergers and expansions in the avionics field include.

• **Electronic Communications Inc.**, St. Petersburg, Fla., will acquire **Advanced Technology Corp.**, Santa Barbara, Calif. Latter is owned by group of scientists who formerly were employed by Aerophysics Development Corp. and Avco Corp. New acquisition specializes in missile system and space vehicle projects. Stanley Jewell will continue as head of new ECI subsidiary.

• **Epsco, Inc.**, Cambridge, Mass., will open new subsidiary called **Monitor Systems Inc.** in the Philadelphia area to develop and produce automatic checkout equipment. Harry H. Rosen has been named general manager of new operation.

• **Kearfott Co.**, subsidiary of General Precision Equipment Corp., has expanded its Asheville, N. C., facilities to 82,500 sq. ft. for production of electromechanical avionic devices.

• **Raytheon** will purchase assets and business of **Sorensen and Co., Inc.**, South Norwalk, Conn., manufacturers of power supply equipment if company's stockholders approve. Leo L.

BENDIX SR RACK AND PANEL CONNECTOR

with outstanding resistance to vibration

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Adding to the efficiency of this rack and panel connector is the performance-proven Bendix "clip-type" closed entry socket. Insert patterns are available to mate with existing equipment in the field.

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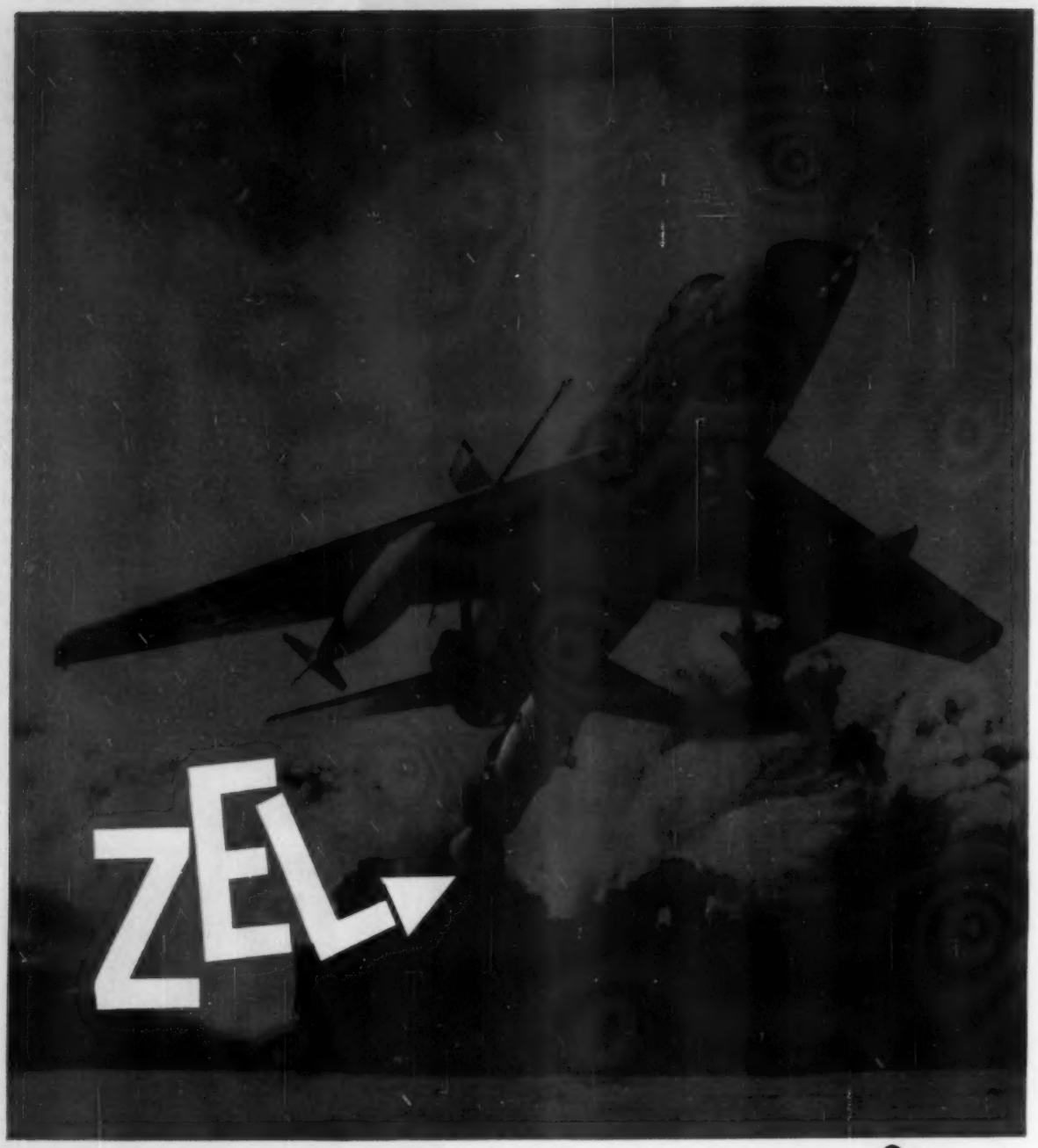
Export Sales and Service: Bendix International Div., 205 E. 42nd St., New York 17, N. Y.
Canadian Affiliates: Aviation Electric Ltd., 200 Laurentian Blvd., Montreal 9, Quebec.
Factory Branch Offices Burbank, Calif.; Orlando, Florida; Chicago, Illinois; Teaneck, New Jersey; Dallas, Texas; Seattle, Washington; Washington, D. C.



Operation Zero Launch: rocket replaces runway!

The Zel system (Zero Length Launch) now makes it possible to disperse and conceal military support fighters near the front lines, far from vulnerable concrete runways. The pilot starts his engine, cuts in his afterburner, then squeezes a trigger that ignites the powerful Astrodyne rocket beneath the aft fuselage. His combat-loaded aircraft roars off its launcher... smoothly, yet so swiftly it's flying 275 miles per hour in less than four seconds.

The power that makes this possible—130,000 pounds of thrust—is delivered precisely and reliably by an Astrodyne solid propellant rocket.

ASTRODYNE, INC., an affiliate of North American Aviation, Inc., and Phillips Petroleum Company, McGregor, Texas.

ASTRODYNE

Helterline, Jr., general manager of Sorensen, will continue to head new subsidiary. Company also has announced plans to establish new integrated electronic anti-submarine warfare and sonar center near Newport, R. I., naval base. Raytheon says new facility may have up to 1,500 employes within three years. Initial construction will be a 160,000 sq. ft. facility. Company has temporarily leased a 15,000 sq. ft. building.

• **D. S. Kennedy & Co.**, Cohasset, Mass., and **Anchor Metals, Inc.**, Hurst, Tex., will merge under the Kennedy name if stockholders approve. Kennedy is producer of large microwave antennas, while Anchor produces large transmission towers.

• **Hazeltine Corp.** has established new 50,000 sq. ft. engineering laboratory in Greenlawn, Long Island, N. Y. Special sonar tank test is being constructed at new facility for anti-submarine warfare work.

• **Thompson Ramo Wooldridge** has purchased 51% of the stock in **Magna Products, Inc.**, Santa Fe Springs, Calif. New acquisition, which provides specialty chemicals and electronic instruments for chemical and petroleum industries, remains under direction of Dr. Gilson H. Rohrback. Company also holds contract from Advanced Research Projects Agency for development of solid propellants.

FILTER CENTER

▶ **Hughes to Enter Inertial Field**—Hughes Aircraft Co. has decided to enter the inertial guidance field. Company has made attractive offers to some of the nation's top inertial guidance scientists in effort to assemble experienced staff.

▶ **Florida Electronics Expansion**—Employment in electronics plants in Florida is up 50% over last year, with total employment of approximately 15,000, according to Florida Development Commission. Martin-Orlando, with 6,500 employes, is the largest in the state.

▶ **Call for Computer Papers**—The 1959 Eastern Joint Computer Conference, scheduled to be held at Statler-Hilton Hotel in Boston, Dec. 1-3, has issued call for papers. Abstracts and summaries should be sent to J. H. Felker, Bell Telephone Laboratories, Murray Hill, N. J. Conference is offering an award of $300 for the best paper delivered at the meeting.

▶ **Signed on Dotted Line**—Major contract awards recently announced by

Molded Harnesses for Missiles

Powered by the tremendous thrust of a rocket engine produced by the Reaction Motors Division of Thiokol Chemical Corporation, the North American X-15—the first manned space vehicle—will exceed speeds of 3600 mph and will penetrate more than 100 miles into space. Revere Molded Harnesses, developed in conjunction with Reaction Motors' engineers, will supply the vital electrical interconnections for this mighty powerplant.

The completely sealed and protected harnesses exceed rigid specifications and provide:

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Harnesses for the X-15 engine are another example of the many types of specially designed Revere harnesses. Electrical interconnections for airborne and ground applications, thermocouple harnesses for heat measurement, molded harnesses for complete environmental protection—all are custom engineered to meet specific requirements.

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- Thermocouple Wire and Cable
- Thermocouples, Harnesses and Leads
- Electrical and Molded Harnesses
- Weight, Force and Thrust Measurement
- Determination of Center of Gravity
- Strain Gage Load Cells

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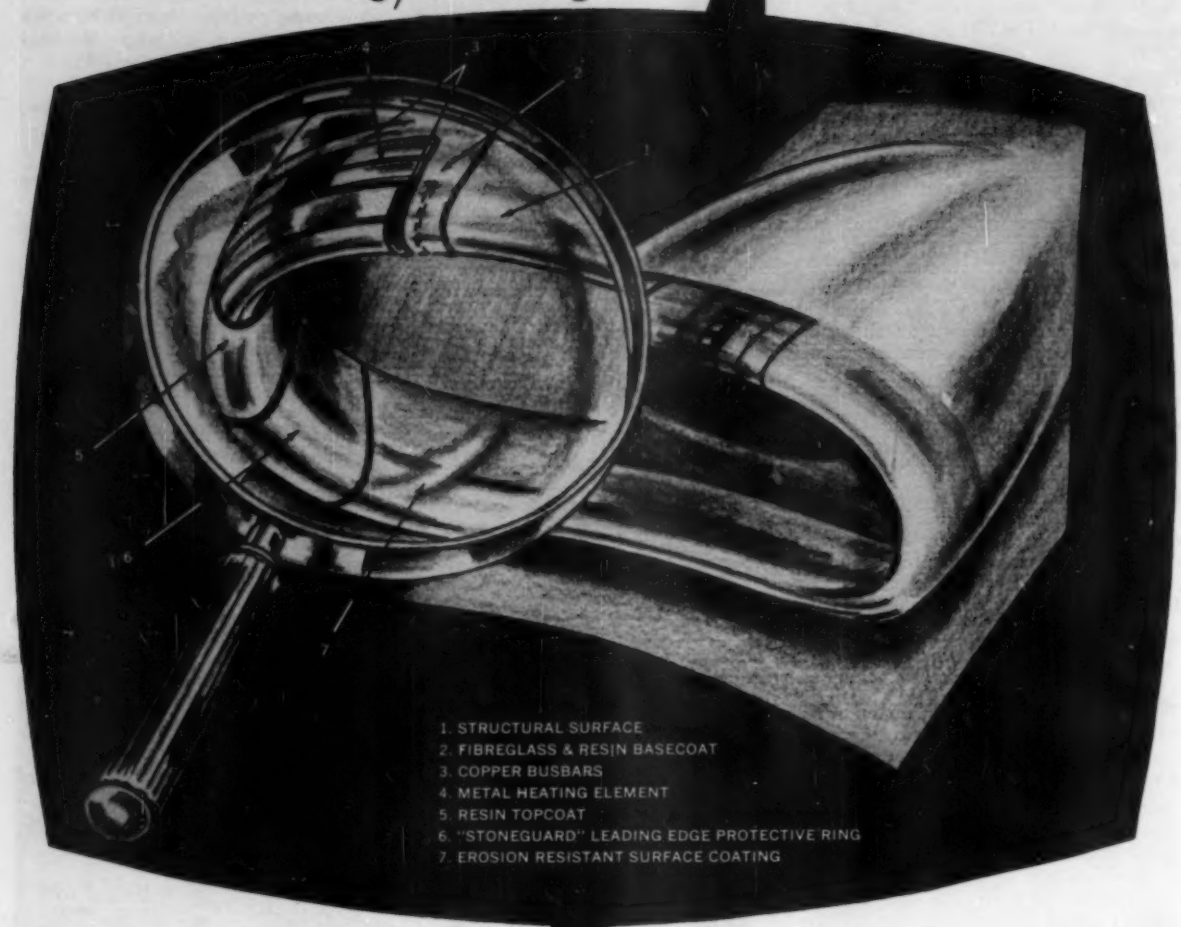
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6. "STONEGUARD" LEADING EDGE PROTECTIVE RING
7. EROSION RESISTANT SURFACE COATING

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SPRAYMAT can be applied to *any* surface, of any material, however complex the curvature. Simple field repairability and aerodynamic and thermal efficiency assures its superiority to any existing system.

Basically, as shown in the above diagram, SPRAYMAT consists of, first, a base of insulating resin; next a layer of metallic heater element of a controlled, predetermined design pattern; and finally a mirror-finish coating of insulating resin. Under normal operating conditions, the service life of SPRAYMAT will exceed that of the aircraft structure itself!

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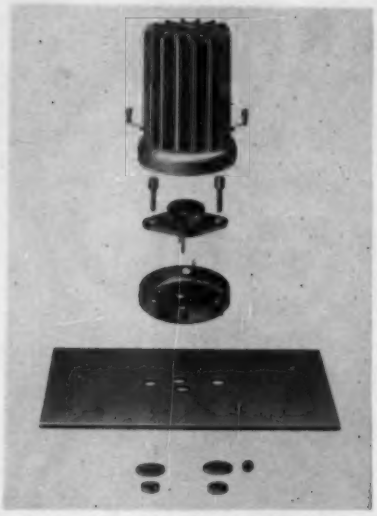

Avionic Cooling Device

Heat dissipator for power transistors provides large finned cooling area to reduce temperature of transistor junction and case. Device is manufactured by International Electronic Research Corp., 145 West Magnolia Blvd., Burbank, Calif.

avionics manufacturers include the following:

• **Collins Radio Co.,** Cedar Rapids, Iowa, contract for approximately $5 million from Rome Air Materiel Area, for construction of communication stations at Air Force bases in California and Massachusetts to extend Strategic Air Command's global communications network.

• **Cubic Corp.,** San Diego, Calif., contract for nearly $1 million from the U. S. Army Ordnance for range instrumentation to be extensively used for tracking missiles at White Sands Proving Ground, N. M.

• **Robertshaw-Fulton Controls Co.,** Aeronautical and Instrument Div., Anaheim, Calif., contract for nearly $1 million from Convair for stability augmentation amplifiers and spares for use on F-106.

• **Cal-Tronics Corp.,** Los Angeles, contract for $½ million from Hughes Aircraft Co. Semiconductor Division for automatic diode test equipment.

• **Admiral Corp.,** Chicago, Ill., a $1.3 million contract from Navy Aviation Supply Office for airborne radio amplifiers.

• **Tamar Electronics,** Santa Monica, Calif., $600,000 award from Boeing Airplane Co. for antenna systems for B-52G.

• **American Electronics, Inc.,** Los Angeles, $1 million from Hughes Aircraft for Falcon missile components; another order for more than $1 million from Weber Aircraft Co. for components for B-52.

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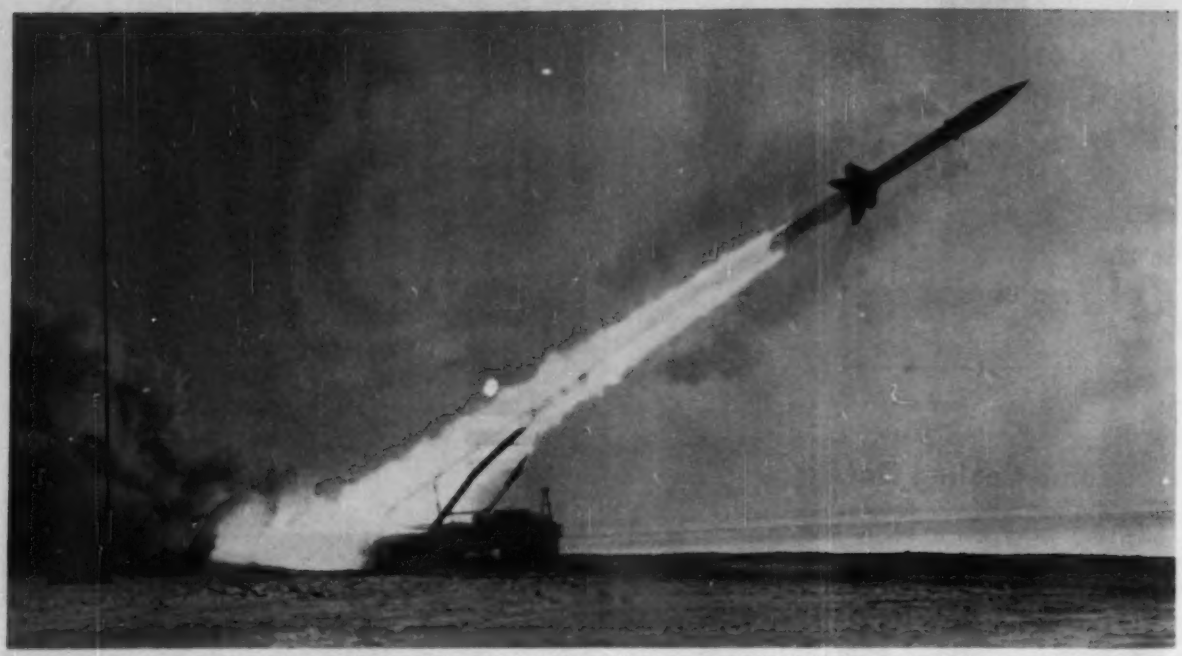


CADRE of Italian army personnel fire an Honest John missile off the Adriatic coast north of Venice in the final phase of their training program, conducted by the U. S. Army's 77th Field Artillery Battalion of the Southern European Task Force's 1st Missile Commaad.

NATO Nations Train in Atomic Delivery

Naples, Italy—United States plans to supply several west European nations, including West Germany, with an atomic weapon delivery capability within the near future.

Program already under way envisions use of both missiles and air-launched systems with the U. S. retaining possession of the nuclear warheads, turning them over to its allies only in event of war.

Italy already has taken to the field with two atomic-capable 15-mi.-range Honest John rocket battalions, replacing two similar units formerly within the structure of U. S. Army's Southern European Task Force (SETAF) headquarters at Verona in northern Italy.

Bilateral Agreement

The U. S. also is training two West German battalions for use of the Honest John and other units for deployment with the Nike Hercules point air defense missile. Bilateral agreement between State Department and Bonn providing these weapons with an atomic capability with the U. S. retaining warhead control is scheduled to become effective later this month barring any objections on the part of Congress.

Other west European nations scheduled to receive Honest John units include Norway, Denmark, Turkey and Greece.

In addition, at least Italy, Greece and Turkey—the three nations included in North Atlantic Treaty Organization's Allied Air Forces—southern Europe—are training their air forces in the LABS toss-bombing technique for delivering nuclear weapon stores. Bilateral agreements that would give these southern European nations access to aerial atomic weapons in time of war are now under discussion.

LABS Technique

Greeks and Turks have been training with LABS technique for the last nine months with Italians cutting in more recently. Greece, which has an excellent training range, probably could obtain an atomic capability within a short time after the bilateral is signed. (As much as a year may be required to bring Turkish and Italian units to the same state of readiness.)

Similar bilaterals also may soon be signed with Turkey and Greece for deployment of intermediate range ballistic missiles. Italian air force already is scheduled to receive the Jupiter IRBM.

Primary purpose in training NATO nations in nuclear weapon techniques is to bolster west European retaliatory and defensive power in the face of mounting Soviet strength, and take up slack stemming from cuts in U. S. Army units in southern Europe.

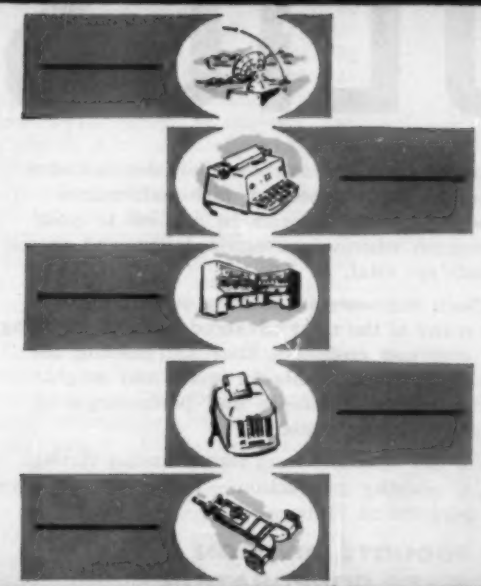
Transitions, however, have not and will not be easy. Lack of education and technical understanding within southern European countries, which until recently have been geared largely to an agrarian economy, are causing severe headaches and growing pains. Even Italy, by far the most advanced industrially of the three nations within the structure of Allied Air Forces in southern Europe, had difficulty in putting together enough qualified personnel to man the two Honest John battalions, according to Allied officials here.

Education Lacking

One top officer in SETAF's combat arm—the first U. S. Army Missile Command headquartered in Vicenza—said the general education of Italians "just isn't good enough. Its a rare thing to find an enlisted man in the Italian army who can add up a column of figures."

Scarcity of technical competence, the officer said, was coupled with political pressures from the Communists who accused the Honest John "of all sorts of hideous things" and with demands from some Italian general officers that

What's new with u ...



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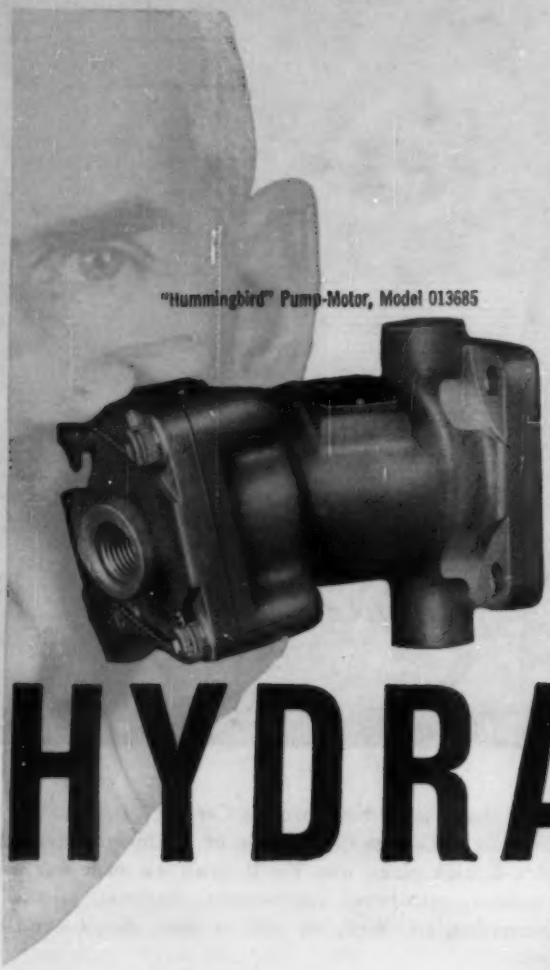

"Hummingbird" Pump-Motor, Model 013685

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the rockets be integrated into the army in the traditional artillery pattern. As it emerged, however, the battalions have been organized into a self-sustaining Italian army missile command similar to the U. S. unit—which is now composed of two 80-mi.-range Corporal missile battalions and probably will fall under the operational control of U. S. Army's Southern European Task Force.

Considering the problems involved, the SETAF officer said, the Italians "are to be congratulated on the speed with which they moved."

Once the political hurdles were largely overcome, organization of cadres for the two battalions began last summer. Cadres were organized and reported to Vicenza in January, and then the pace picked up rapidly. With U. S. Army backing, cadres began training the remainder of personnel for the two battalions in March. Thus far, each battalion has fired four Honest Johns each in training operations and is listed as operational.

U. S. ARMY personnel supervise Italian army cadre in loading Honest John on launcher (above). Below, Italian cadre service Honest John under direction of 77th Field Artillery.

Manpower Deficiencies

Concern of the SETAF officer over the problems of integrating relatively modern weapons into the national forces of southern Europe also is felt here at the headquarters of Allied Forces-Southern Europe, which is headed by U. S. Adm. Charles R. Brown and has responsibility for the defense of the three NATO nations in this area, and by officials of its subordinate command, Allied Air Forces-Southern Europe.

A ranking officer on Adm. Brown's staff says the command is battling to overcome manpower "deficiencies in both quantity and quality. Italy, Turkey and Greece, he adds, "are supplying the maximum they can support, and that's not enough."

U. S. Air Force Lt. Gen. Richard C. Lindsay, commander of Allied Air Forces-Southern Europe, believes the over-all technical competence of Greece, Turkey and, to a lesser extent, Italy may be stretched to the limit when these countries are called upon to cope with the intricacies of nuclear warfare.

Discussing plans to provide the three nations with an atomic weapon system delivery capability—which he wants since it could roughly double the striking power of his force of 1,000 tactical jet aircraft—Gen. Lindsay says: "The problem is that in each of these countries there are only so many individuals with the basic education and technical know-how who can handle these more sophisticated systems, and we are always putting a greater demand on these nationals so we make progress with weapon systems and have to take away from this pool of resources, so we find ourselves taking a step backward in this respect."

Turkey already is taking a step up the technological ladder, having taken delivery on 30 North American F-100Ds as partial replacement for its force of Republic F-84F tactical fighters. More F-100Ds are in the pipeline to Turkey—they also will eventually go to Italy and Greece—and all three countries will acquire limited quantities of the Fiat G.91 NATO tactical lightweight fighter to replace a portion of its F-84 fleets. The F-84, however, will continue to play a large part in southern Europe.

Major U. S. contribution to Gen. Lindsay's force, which is charged with the aerial defense of southern Europe, is three squadrons of F-100D and F-100F aircraft, two stationed in Italy

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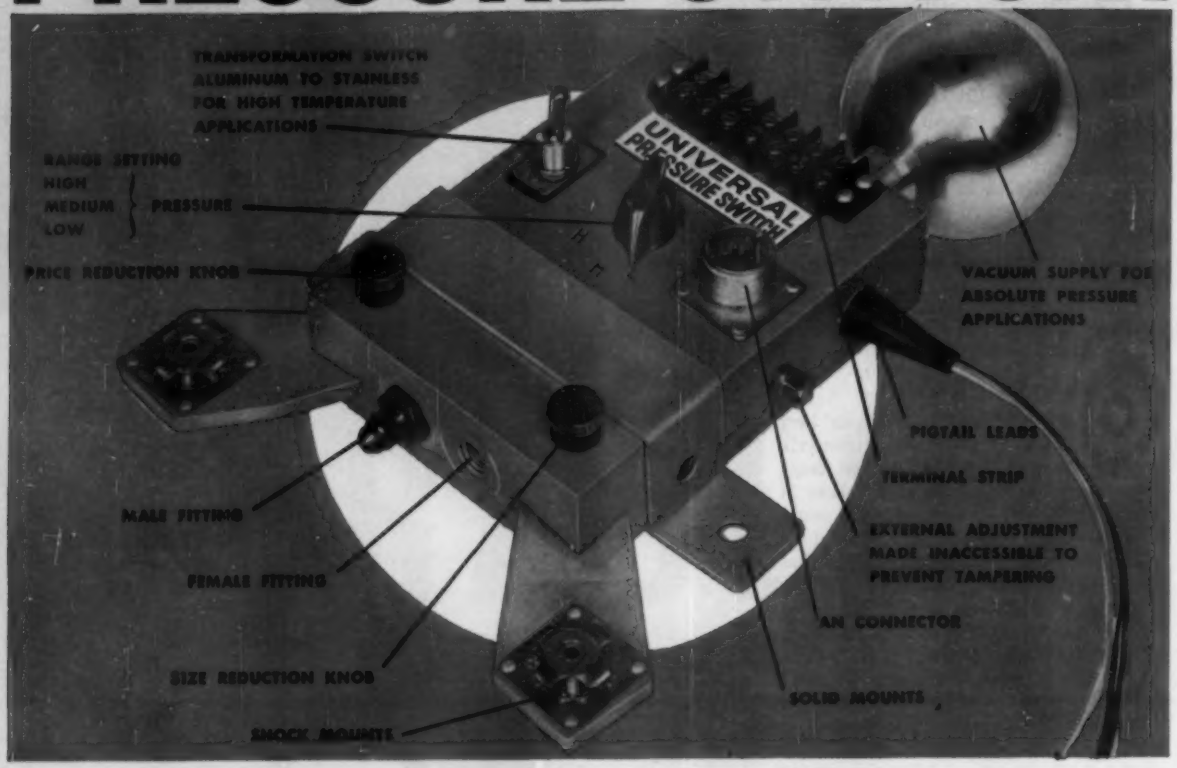

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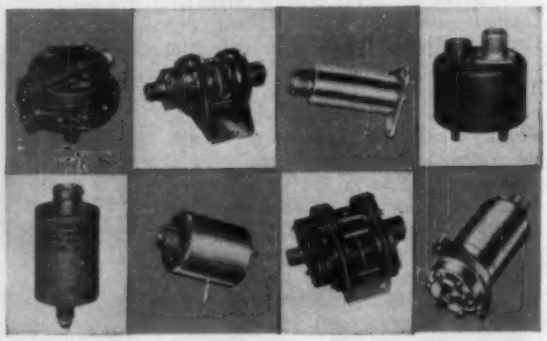

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and one in Turkey. The three squadrons now represent NATO's aerial atomic force within the confines of Allied Forces-Southern Europe.

In discussing the over-all problem of placing unaccustomed weapon systems and equipment into the hands of the armed forces of this area, the SETAF officer believes the U. S. often is much to blame in the difficulties that arise.

He says: "when we start a program such as this, the tendency is to say, 'well, we'll give them two battalions of Honest Johns,' without realizing that the support equipment—communications, ordnance, electronics—is not in their army or that they have no system to provide proper logistics.

"Here's a typical example of one of our foul-ups. They (the Italians) bought from us portable radios run by a battery-pack charged by a Fiat jeep-type vehicle's generator. But the motor on the Fiat vehicle they use isn't strong enough to charge the battery pack.

"So now what do you do? You have to redesign the radios or sell them a bunch of vehicles to go with the radios. So, the upshot of this is that the Italians now carry two sets of two 12-v. batteries each. They run two batteries with the vehicle to charge the battery pack, while the other two are back being recharged. It's not a very successful or efficient way to run these things."

Soviet Il-28s Carry Air-Ground Missiles

With the U. S. Sixth Fleet—Soviet Il-28 medium range bombers are being equipped with 50-mi. range air-to-surface missiles capable of attacking either ground or naval targets, according to Sixth Fleet intelligence officers.

Missile is believed to be based upon the German Comet technique developed during World War II. Soviet aerial and defensive capability also has increased during the past year.

New fighter aircraft, including the MiG-19, have been introduced to the operational forces during the past 12 months, and some of Soviet's medium bomber force has been modernized, according to Lt. Gen. Richard C. Lindsay, commander, Allied Air Forces-Southern Europe, headquarters in Naples.

Primary bomber force modernization is introduction of Ilyushin Il-28-equipped satellite forces, to replace Ilyushin Il-10s. All-weather capability also has been improved.

As in eastern Europe (AW June 22, p. 79), the Russians are believed to be basing Yak-25 all-weather interceptors in the satellite countries of Bulgaria and Rumania. During the same period, the Russian air force has substantially boosted its aerial activity, concentrating on all-weather flying in air defense.

This announcement appears as a matter of record only.

NEW ISSUE June 30, 1959

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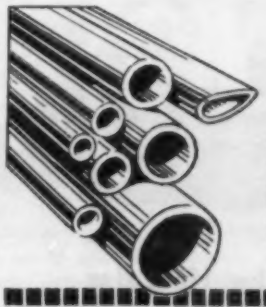

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Bolkow to Handle Nord's 5103 Missile

Paris—Nord Aviation has designated Bolkow-Entwicklungen of Munich exclusive representative in West Germany for the Nord 5103 air-to-air missile. The weapon meets Shape requirements for air-to-air missiles and has been tested on several European aircraft, including the Fiat G.91 which will be manufactured in Germany.

Bolkow will also study and develop the installation of the 5103 on German-built aircraft, and be responsible for the maintenance of associated equipment.

This specific agreement is part of a general accord between the companies covering collaboration in study, production and maintenance of missiles for both the French and German military services.

AMC Contracts

Wright-Patterson AFB, Ohio—Following is a list of unclassified contracts for $25,000 and over as released by the Air Materiel Command:

Graphic Films Corp., Hollywood, Calif., production of a motion picture entitled "Survey of Astronautics," project 19293, (PR EM-9-MP-6369), $56,949.

Flight Propulsion Division, General Electric Co., Cincinnati, Ohio, 40 ea., J79-GE-7 turbojet aircraft engines, data and bill of materials for German F-104 aircraft, (PR EP-9-2840-4777), $5 million.

Watertown Division, The New York Air Brake Co., Watertown, N. Y., 16 ea., high temperature variable delivery hydraulic pumps, contractor's model 69W030, 400F (for evaluation of high temperature, hydraulic fluid properties and their effect on hydraulic pump performance), (PR EB-9-RD6180), $73,040.

Hughes Aircraft Co., Culver City, Calif., modification of MA-1/ASQ-25 AWCS to achieve compatibility with time division data link, (PR EG-9-11B-4740), $680,000.

The Kuljian Corp., Philadelphia, Pa., architectural and engineering construction inspection services for family housing. (PR PD-9-8-1062), $37,891.

Hughes Aircraft Co., Culver City, Calif., AN/ASQ-25 aircraft and weapons control systems, engineering services and materials and data for F-106B aircraft, (PR EG-9-11B-4709), $3 million. Red Bank Division, Bendix Aviation Corp. Eatontown, N. J., 139 ea., panels, control, d.c. generators with regulators, Bendix part No. 40E56-4-A, Aerno 42-0747, including data for F-102 aircraft, (PR SA-9-03C-8352), $50,253.

Republic Aviation Corp., Farmingdale, N. Y., program implementation for F-105D aircraft (for Fiscal 1960), (PR TF-9-1510-7296), $10 million.

Southwest Research Institute, San Antonio, Tex., service test evaluation of jet fuel, (JR EM-9-RD-6265), $66,333.

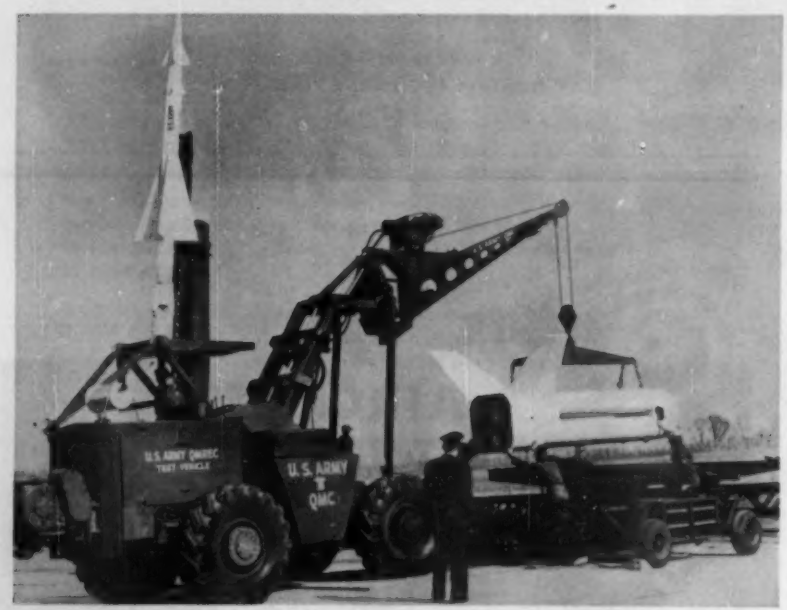
Borg Equipment Division, Amphenol-Borg Electronics Corp., Janesville, Wis., 1,983 ea., indicators, ID-250A/ARN and spare parts for: USAF Tacan retrofit program for various fighter, bomber and cargo aircraft, (PR's MD-9-16A-35252 and amendment No. 2 (partial) and amendment No. 4 (complete); SB-9-16A-5029 (partial); MA-9-16A-1048 (partial), $244,510.

Fairchild Camera & Instrument Corp., Syosset, N. Y., 51 ea., lens cones, type C-2A, Aerno 74-0232, spare parts and data for use with type D-3A camera body, (Aircraft RF-101). (PR MO-9-6760-2147), $285,942.

Electro-Data Division, Burroughs Corp., Washington, D. C., 3 ea., magnetic tape units, Burroughs model 544, end use: to provide additional capability for ATIC Datron computer, model 205, (PR 9(9/1)-4239-A), $36,000.

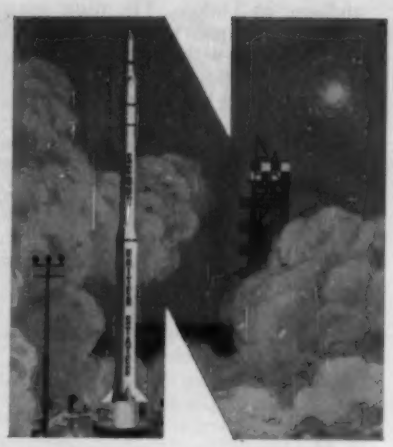
Silicone Products Department, General Electric Co., Waterford, N. Y., fluid silphenylene (experimental lubricant) to be service tested, (PR PM-9-RD-6105), $30,575.

Westinghouse Electric Corp., New York,



Army Vehicle Loads Nike Hercules

Missile handling vehicle, being evaluated by the Army, loads a Nike Hercules booster onto launching rack. Designated the Telefork 102, the vehicle can be converted from the 16 ft. crane, above, to a conventional fork lift. Telefork, developed by Clark Equipment Co., has a capacity of five tons.



VOUGHT WILL BUILD NASA SPACE ROCKET

Scout is the name of a new four-stage rocket to be used in NASA research. It will boost 150-pound satellites into earth orbit and fling 1,000-pound instrument probes as far out as 5,000 miles. The beauty of *Scout* is that it will do these things at relatively low cost—about $500,000 per vehicle, according to NASA.

Chosen to build this new approach to space research is Chance Vought's new space development team. This group already has come along fast in areas such as fitting man to a space machine, providing him escape devices and instrument displays.

For example, in Vought's unique orbital flight simulator, NASA and company pilots have already "flown" by the new rules of space, using the same family of instruments the first space navigators will use.

Designing for spacemen is new to Vought, but exploring unknown regions isn't. For more than 40 years, Vought has worked on the frontier in the "human factors" of aircraft design. Matching man to aircraft, the company has pierced imposing barriers to higher and faster flight. Matching man to spacecraft, Vought will continue to extend frontiers.

Astronautics is just one in the broad spectrum of Chance Vought fields of activity. Other areas include: design and production of high-performance missiles and aircraft, antisubmarine warfare, electronics, advanced weapons, range systems management, advanced control computer systems.

CHANCE VOUGHT
DALLAS, TEXAS

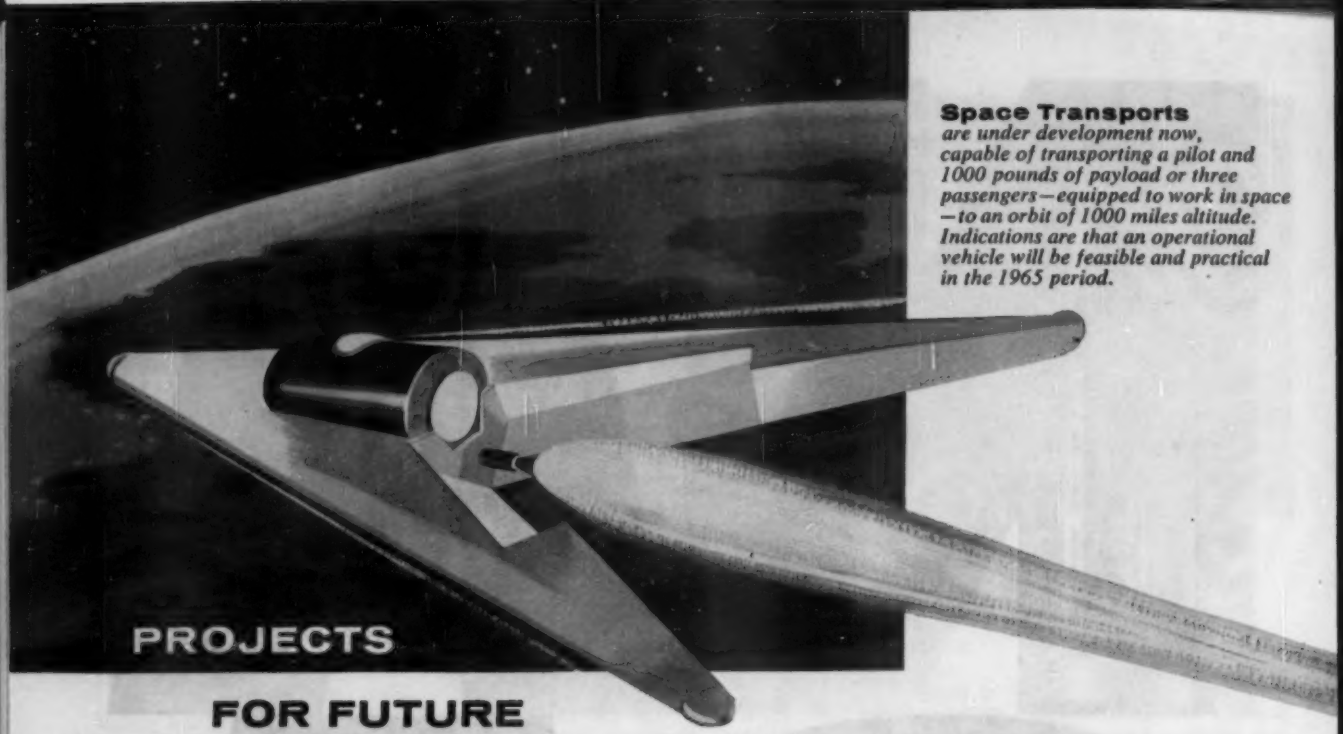
America's civilian space agency proves

IT'S GOOD BUSINESS TO EXPLORE SPACE

Weather forecasts hatched in space will save billions of dollars a year. Satellite transmitters will beam our television programs around the world. In these and other ways, space will pay back the money spent on exploration. Making facts out of these forecasts is part of the job of the National Aeronautics and Space Administration, the engineer-scientist agency that manages U. S. non-military aerospace programs. NASA adds a condition to predictions of a world space-trade boom: space, itself, must remain free. This freedom, NASA men know, depends on whether America leads or lags as a space explorer.

ASW G

CHANCE VOUGHT
DALLAS, TEXAS



Space Transports *are under development now, capable of transporting a pilot and 1000 pounds of payload or three passengers—equipped to work in space—to an orbit of 1000 miles altitude. Indications are that an operational vehicle will be feasible and practical in the 1965 period.*

FOR FUTURE DECADES IN SPACE... *another Lockheed Progress Report to Engineers*

Plotting the nation's future space exploration projects requires the capabilities of a forward-looking company; one with vision, superiority in technical skills and advanced facilities. Lockheed, Burbank, long a leader in extending the science of flight, is placing its vast resources and accumulated knowledge into programs designed to provide major breakthroughs in the fields of: Basic and applied research; manned aircraft of advanced design; missiles and spacecraft. Shown here are artists' renderings of a few of these important projects. Such project diversification calls for high-level technical skill, offers genuine challenge to experienced engineers. At Lockheed these varied projects require engineers in many fields. Take advantage of this need. Go forward with a forward-looking company: Lockheed, Burbank.

Supersonic Transports—have held an important place in our thinking for the past several years. Extensive wind tunnel tests have been conducted on many design concepts, supplemented by exhaustive laboratory and structure studies. Lockheed is prepared to build an airliner that will travel at speeds in excess of Mach 3 at an altitude of 75,000 feet.

Infrared Systems studies are being conducted using an advanced method of detecting fast-moving missiles and high-speed aircraft. A new facility, which includes an advanced laboratory, with an infrared tunnel, for basic research and development of prototype equipment in this expanding field, has been set up to push Lockheed, Burbank, to the forefront in infrared study.

Vertical Take-off and Landing Projects—Lockheed, Burbank, is engaged in exploring the potential of VTOL projects on a very broad scale. Different VTOL features are embodied in each proposal. Considerable emphasis is being placed on VTOL "air recovery" vehicles, designed for air rescue and reentry missiles recovery missions.

Solar Radiation Studies—are being conducted at Lockheed's flight test radio station at Briar Summit, California, placing particular emphasis on solar flares as our contribution to the International Geophysical Year. We have already accumulated more than a quarter of a million images of the sun for analysis. In cooperation with other companies, we will determine the processes by which solar energy is released.

High caliber scientists and engineers are invited to take advantage of Lockheed's outstanding career opportunities. Openings now exist in: Electronics; aero and thermodynamics; propulsion; servo-mechanisms; materials and processes; structures and stress; operations research; research in optics, infrared, acoustics, magnetohydrodynamics, instrumentation, mechanics and hydraulics; mathematics; and in all phases of design. Write today to: Mr. E. W. Des Lauriers, Manager Professional Placement Staff, Dept. 11071, 2400 North Hollywood Way, Burbank, California.

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3 ea., ruggedized single stage intensifier image Onthricon and reports (aerial reconnaissance) for aircraft unknown, (PR PE-8-ST-3747), $298,452.

John Oster Manufacturing Co., Racine, Wis., fuel management computing system (for service test) IFB 33-600-59-188), $94,-955.

Missile Systems Division, Raytheon Co., Waltham, Mass., 13 ea., Raytheon Rayspan spectrum analyzers, model MRFR 30-2, (PR 913205-A and amendment No. 1.), $182,500.

Collins Radio Co., Cedar Rapids, Iowa, 4 ea., computers, universal flight director, drawings and data for service test, (PR EA-9-ST-4486), $87,970.

Long Beach Division, Douglas Aircraft Co., Inc., Long Beach, Calif., materials handling support system, (PR 47927), $673,-390.

Autonetics Division, North American Aviation, Inc., Downey, Calif., all-weather landing set, AN/APN-114 for: service test in TF-102 aircraft, (PR EC-9-ST-4824), $187,600.

Wenadrop and Northrup, Architects, Rochester, N. Y., architectural engineering services (construction inspection services of 270 unit family housing project at Griffiss AFB, N. Y.), (PR PD-98-1082), $61,933.

Red Bank Division, Bendix Aviation Corp., Eatontown, N. J., 35 ea., generators, 20 kva., a.c., 3 phase, Aerno 42-6053; 60 ea., regulators, voltage, a.c., Aerno 42-6061, engineering and maintenance data for: F-104D aircraft, (PR EA-9-03C-4792), $109,451.

Laboratory for Electronics, Inc., Boston, Mass., flight test program for AN/APN-105 (XY-2) doppler-radar system, applicable to F-105 aircraft. (PR EC-9-16K1-4542), $236,954.

The Martin Co., Baltimore, Md., TM-76B missiles, spare parts, technical data and handbooks, (PR's TM-9-1410-7248 and TM-9-1410-7294), $10 million.

Admiral Corp., Chicago, 3,945 ea., controls, radio set, C-1904/ARC-27, maintenance spare parts and data, end use; AMA class IV modification, (PR's MD-9-16A-35315 and MD-9-16A-35167 and amendments four and five), $582,295.

Solar Aircraft Co., San Diego, Calif., 25 ea., gas turbine engine power units, P/N 13042-500 airborne type A/A24A-17 and maintenance data for KC-97 aircraft, (PR WR-9-02B-2410), $256,805.

Air Arm Division, Westinghouse Electric Corp., Baltimore, Md., development of dendritic approach to molecular engineering, (PR 08815), $1,925,142.

Douglas Aircraft Co., Inc., Long Beach, Calif., 1 ea., C-133A/B-1 mobile training unit, (PR TK-9-28-7282), $120,000.

General Metal Products Division, General Tire and Rubber Co., Akron, Ohio, 2,966 ea., wheel assemblies, main, 30x8.8, type VII, Aerno 41-1690, maintenance and engineering data for F-100D and F aircraft, (PR 00-9-1630-2811), $685,146.

Bendix Products Division, Bendix Aviation Corp., South Bend, Ind., 347 ea., wheel assemblies, main, 56x16, type VII, Aerno 41-7359, data and spare parts; 1,349 ea., brake assemblies, for 57x16 wheel, Aerno 41-7358, spare parts and data for B-52C, D, E, F and G aircraft, (PR's EA-9-03B-4390, EA-9-03B-4413 and amendment No. 1; 00-9-03B-2801 and amendment No. 1), $1,-762,457.

Collins Radio Co., Grand Rapids, Iowa, 5 ea., indicators, horizontal situation, progress reports, installation drawings and diagrams and mating electrical connectors for a service test, IFB 33-600-59-158(PE EA-9-05C-4592), $98,000.

Continental Aviation and Engineering Corp., Detroit, Mich., 6 ea., J69-T-29 engines for Q-2C drone aircraft, (PR EP-9-2840-4795), $78,837.

The Lewis Engineering Co., Naugatuck, Conn., 3 ea., testers, temperature instruments, electrical (field), specification and engineering data for use in checking and calibrating aircraft temperature instruments and field level, (PR EM-9-RD-6229), $36,068.

The Brush Beryllium Co., Cleveland, Ohio, 182 ea., beryllium specimens for laboratory testing to determine its light weightness for potential Air Force use, (PR PM-9-RD-6132), $27,478.

FIRST OF THE FASTEST— The Convair 880, fastest jet transport yet built! Capable of a maximum cruising speed of 615 miles an hour, the 880 is being built for airlines both in this country and abroad.

To solve the problem of regulating throttle control cables on Convair's 615 MPH jet airliner—Pacific Scientific custom-designed and built a NEW Cable Tension Regulator that combines into *one unit cable regulation for all four of the 880's jet engines!*

Each of the engines has two primary controls—and as each control utilizes two cables—this means the Pacific Regulator must handle a total of 16 cables!

Purpose of this *new* Pacific Cable Tension Regulator Package is to compensate for change in cable lengths as a result of wing deflections and temperature changes—and to maintain cables at the exact tension at which they are rigged, providing unvarying engine control.

Cable regulation is important on jet transports as thin high-speed wings present a wider latitude of deflection than conventional aircraft—and temperatures vary wider and faster due to higher rates of climb and cruising altitudes. Pacific Cable Tension Regulators are the most effective means of compensating for this thermal variation and the *only* device capable of compensating for mechanical deflections.

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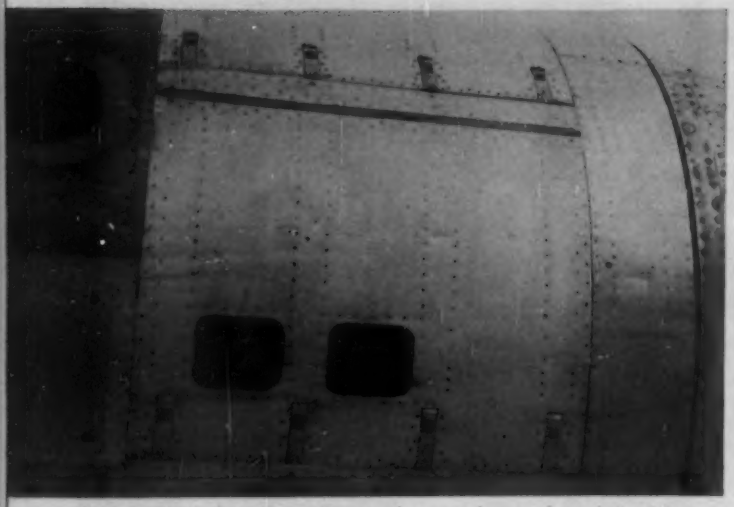
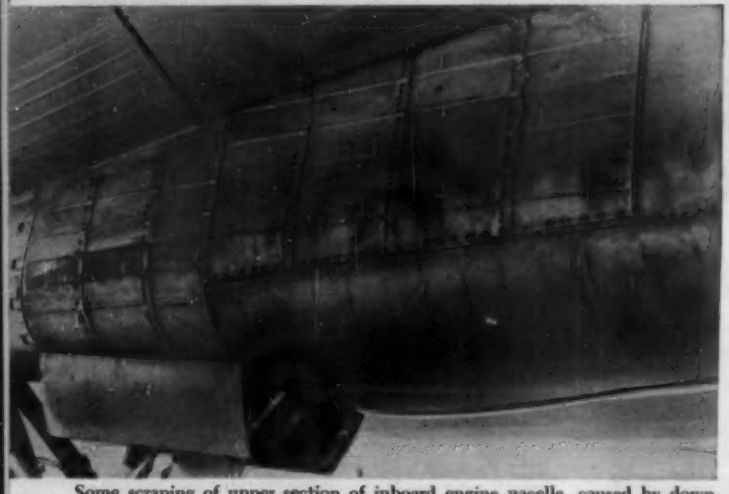


Large sections of engine cowling can be opened upward on their piano-type hinges by pushing on quick-release fasteners. Numerous observers noted that Russians apparently did little checking of airplane during its New York stay.



Some scraping of upper section of inboard engine nacelle, caused by downward travel of wing flap was visible (upper right). Smooth area under beaded portion of rear of engine nacelle is clamshell door that covers backward retracting main landing gear.

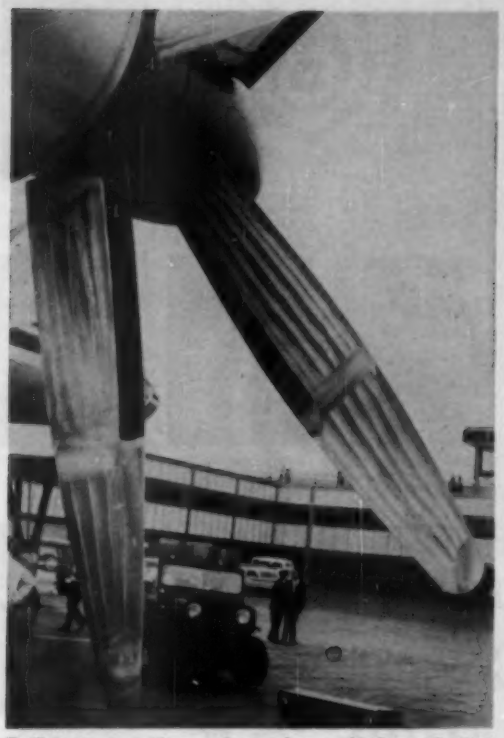
Tailpipe is faired into rear of outboard engine nacelle. Adjacent wing and flap areas are reinforced with beaded metal covering to withstand blast effect. Blast impinges directly on underside of wing, causing minor cracks (see photo upper right).

Only fatigue cracks readily visible on Tu-114 were those under left wing behind outboard engine nacelle in path of engine exhaust. One such crack (upper center) has been welded, another in the same path appears visible extending underneath it. At lower left center, a third crack has been stopped by drilling a hole at its terminus.

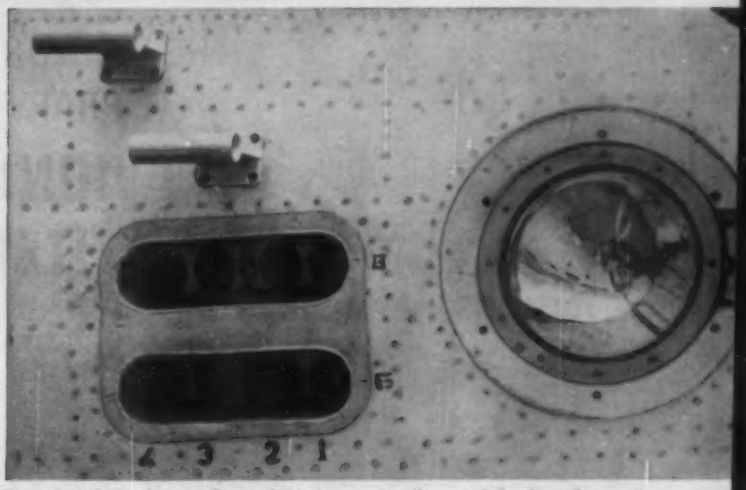
First Design Details Of Tu-114 Revealed In Visit to U.S.

Cabin air conditioning system is fed by intake under Tu-114 belly. Pressurization is supplied by taking air from last compressor stage of each engine. System provides equivalent of 8,072 ft. when Tu-114 is at 32,800 ft.

Knotty stress problems, particularly in landing, are imposed by far-forward projecting nacelles, according to a U. S. aviation engineer observer. Engines develop more than 12,000 shp. each. Props are reverse pitch, use electrical and hydraulic system, with pneumatic system for feathering in emergency. Synchronization is automatic.



Buffing, to smooth rear faces of prop blades and eliminate nicks caused by foreign objects, forms definite patterns. Leading edges of 18.3-ft. diameter props are electrically anti-iced.



Ports just behind nose (lower left) house signalling and landing flares. A landing light is retracted at right. Total temperature gage ducts are paired above flare ports.

Rearward-retracting nose gear is scaled by Idlewild technical employe who stands six-feet tall. Tires were worn smooth by heavy braking following ground-controlled radar approach to N. Y. International Airport.

Four-wheel rearward retracting main landing gear provides large footprint for landing on conventional airports. Tu-114 is capable of taking off loaded at 150 tons in 6,500 ft.

1 Lightweight NAV/COMM system for single engine aircraft

2 All weather NAV/COMM services for light twin aircraft

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4 VHF Transmitter with 25 watts output on 360 channels

5 VHF Transmitter with 25 watts output on 680 channels

6 Lightweight 90 channel VHF Transmitter, 3 watts output

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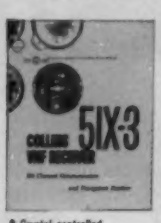


8 Crystal controlled 190 channel VHF NAV/COMM Receiver

9 Modular Marker Beacon Receiver with 3 light service

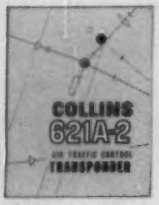
10 Completely transistorized high fidelity PA Amplifier

11 Global communication with 144 channel HF Transceiver

12 VHF Communication-Navigation Receiver, tunes 108-136 mc

13 Top sensitivity in transistorized Doppler navigation

14 Ten or 20 channel modularized Glideslope Receiver



15 Reinforced radar reply and identification Transponder

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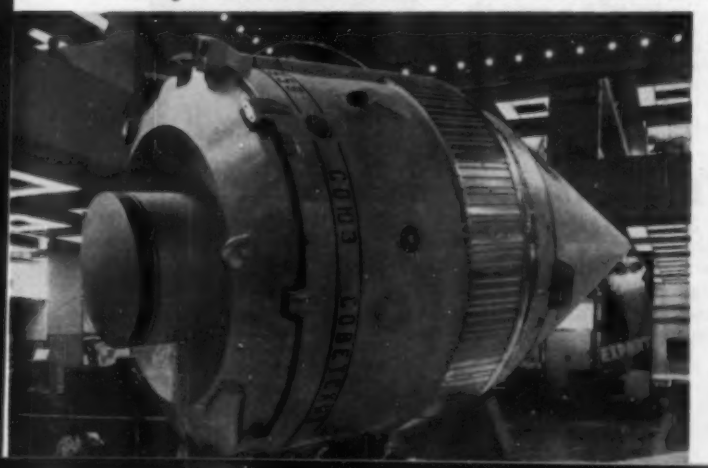
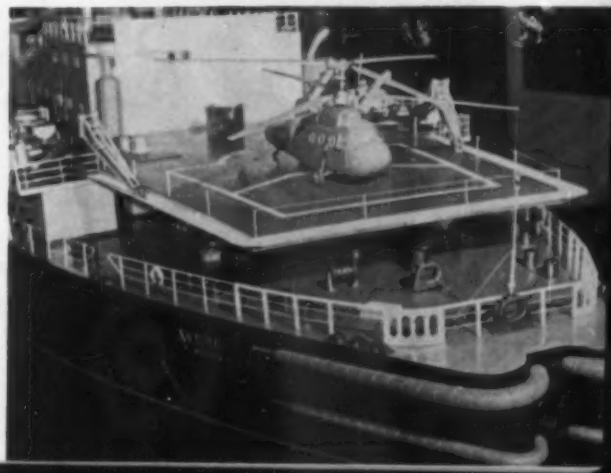
Full-scale model of final stage of Soviet Union's solar satellite, Mechta, is on display at the Soviet Exhibition of Science, Technology and Culture in New York. Diameter is about 10 ft. and length about 20 ft., including protective nose cone that is separated as soon as the rocket has penetrated the dense lower atmosphere. Weight is given as 3,250 lb. Windows in the nose cone provide a view of instrument package mockup. Nose cone separates along the line just behind the windows, possibly by two small rocket engines. One of two exhaust ports can be seen along separation line between the two windows. Two VHF antennas are mounted immediately forward of lettering on base which says, "Union of the Soviet Socialist Republics—January, 1959." One 20 meter antenna extends along the top of the stage and connections for a second can be seen on the bottom, but the antenna is not mounted because of the carrying dolly. Four of the eight hold-down clamps used to lock the final stage to the previous stage can be seen around the base. One of the two ejection ports that ejected sodium to create an artificial "comet" is above the upper VHF antenna. Instrument package (AW June 29, p. 53) was ejected from the final stage after burnout so that a total of four objects were placed in solar orbit: payload, final stage, and two clamps with timing mechanisms that secured the two 20 meter spring antennas of the instrument package until it was clear of the final stage.

Soviets Display Mechta, Helicopter Models

Second sodium ejection port can be seen at lower left. Also visible are the two cable channels along the top and bottom of the model. Junction boxes at the base provide interconnection with the previous stages for stabilization and control systems mounted in the final stage. Helicopter displayed on a landing platform on a model of the Soviet nuclear powered icebreaker Lenin is a new Kamov design following in the Ka-15 and Ka-18 coaxial series. Soviet sources at the exhibit said the helicopter is under construction.





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Picchio F.15 Designed for U.S. Market

By Edith Walford

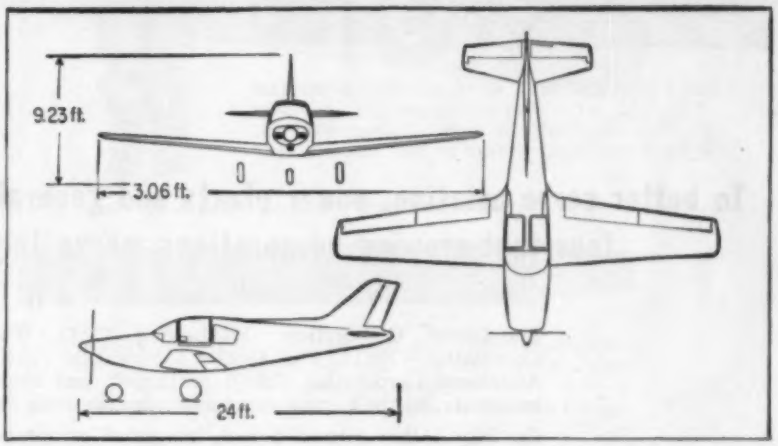
Milan—Picchio F.15 three-seater, latest in the series of sport and business planes designed by Italian engineer Stelio Frati, made its first flight earlier this month.

First prototype, built by Procaer S. P. A. of Milan, was shown by the company at this year's Paris air show.

The plane can be used for aerobatics, the company says, and was designed for sport and business flying purposes. Procaer S. P. A. expects to demonstrate that the plane complies with American civil air regulations and then plans a first production series of the Picchio F.15.

The firm hopes to generate considerable commercial interest, particularly in Germany, Switzerland, Austria, Belgium and Africa where its approximate price of $13,000 is competitive with other comparable designs.

PICCHIO F.15 has aluminum-alloy covered plywood panels for skin. Cantilever wing and fuselage nose are constructed in one piece as an integral unit. Cockpit doors swing upward.



All-Wood Structure

The Picchio F.15 is basically an all-wood structure with aluminum-alloy covered plywood panels for skin, but the forward fuselage and other sections which might be exposed to fire are protected with stainless steel.

Powerplant is a direct drive Lycoming O-320B engine developing 160 hp. at 2,700 rpm.

The propeller is a constant speed Aeromatic type.

The low cantilever wing and fuselage nose are constructed in one piece as an integral unit.

Wing profiles are NACA 640 series. Root thickness of the wings is 15%, thickness of the wing tips 9½%. The wooden framework has an aluminum-alloy plated skin and the landing gear retracts into a well in the root.

Balanced Ailerons

The ailerons are balanced dynamically and controlled partly by rigid tubes, partly by cables. The flaps are worked mechanically allowing them to be selectively used for either takeoff or landing.

Framework of the fuselage is made entirely of wood and is oval in section. It is built in two units. The front piece including the cockpit is one section with the wing; the other to the rear comprises the fin and the horizontal tail. The two sections are joined by bolts.

The two-spar fin and stabilizer are both made of wood. The rudder is operated by cables; the elevator by cables and rigid tubes.

Both fuselage and tail unit including removable parts are covered with plated plywood panels.

The engine is mounted with four bolts.

The two doors of the cockpit opening upwards latch in open position giving easy access to both the pilots' seats in front which are adjustable. A roomy bench seat is also provided for the third passenger immediately behind the pilots' seats. The pilot has all-round visibility and two spacious windows, one on either side of the back bench, allow the third passenger also a good view during flight.

The Picchio has a dual control system with two conventional sticks and rudder pedals. When the landing gear is down, the rudder pedals are connected to the nosewheel which facilitates better handling of the aircraft on the ground.

Connection with the nose wheel is interrupted automatically when the latter is retracted.

The aircraft has a retractable tricycle type landing gear. The nosewheel, fitted with a 5.00 x 5 low pressure tire, retracts backward into a well in the fuselage nose; the main gear retracts into the wing root. The gear is operated by an electrical motor and in case of emergency by a mechanical level control.

The telescopic nose wheel is fitted with an oleo-pneumatic long-run shock absorber.

Main landing gear has an independent oleo-pneumatic shock absorber. The main wheels are fitted with 6.00 x 6 low pressure tires and have hydraulic brakes which are operated simultaneously by an additional pedal placed

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To better serve aviation, power plants and general industry ...four fast-growing corporations merge July 1, 1959

Prat-Daniel Corporation (Established 1924), The Thermix Corporation (1941), The Aerotec Corporation (1942) and The Aerotherm Corporation (1950) are known and respected internationally for their engineering and manufacturing skills.

On July 1 they formed a new, integrated corporation, Aerotec Industries, Inc. — having carefully studied the advantages of centralizing management and consolidating their financial and manufacturing resources. Management of the new organization remains in the hands of the experienced executives of the merging companies.

The new Aerotec Industries, Inc. has three divisions:

The **Aircraft Equipment Division,** Greenwich, Conn., designs, produces and sells a wide range of controls for aircraft, missiles and nuclear applications.

The **Aerotherm Division,** Bantam, Conn., develops, fabricates and sells aircraft seating and accessories.

The **Industrial Division** engineers, manufactures and sells electrical precipitators and mechanical dust collectors for flyash and industrial applications, as well as air preheaters, curtain dampers, blowers and fan-stacks. Its facilities include a plant in Greenwich, Conn., and the Prat-Daniel plant in South Norwalk, Conn.

An expanded and intensified program is now underway to accelerate research, new developments and technical advances that will benefit you. If you have any problems or requirements in the above fields our engineers are ready to help solve them.

Write Aerotec Industries, Inc., Dept.-W, Greenwich, Conn.

Picchio Specifications

DIMENSIONS	
Wingspan	30.6 ft.
Length	24 ft.
Height	9.23 ft.
Wing area	131.5 sq. ft.
Aspect ratio	7.1
WEIGHTS	
Empty weight	1,344.8 lb.
Useful load	
Pilot and passengers	5.18. lb.
Baggage	77.1 lb.
Fuel	264.5 lb.
Total useful load	859.6 lb.
Wing loading	16.8 lb./sq. ft.
Power installed	160 hp.
Power loading	13.7 lb./hp.
PERFORMANCE	
Maximum speed	136.5 mph.
Cruising speed	168 mph.
Minimum speed with flaps	53 mph.
Takeoff distance	582 ft.
Landing distance	493 ft.
Service ceiling	18,750 ft.
Range	775 mi.
Endurance	5 hr.

under the rudder pedals in the cockpit.

Fuel is carried in one 19 gal. and one 17 gal. tank, one behind the fire wall, the other behind the passenger's seat. The engine can be fed from either tank. Their capacity allows a 5-hr. flight which corresponds to a range of approximately 745 mi.

The electrical system has a 24v. battery and a 28v. 15-amp. generator mounted on the engine. The system comprises engine starter, electric control of landing gear, fuel tank gage, flying and panel lights, and radio.

Instrument panel is arranged with flight instruments on the left comprising air speed indicator and as optional extras a remote compass indicator, an artificial horizon and a turn and bank indicator. The VHF radio is located high up in the middle of the panel and all electrical system controls are below. The engine instruments are on the right and comprise the engine tachometer, oil thermometer, oil pressure indicator, fuel pressure indicator and the fuel quantity gage.

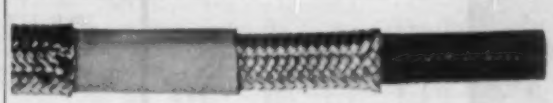
Sugar Cane Borer Controlled From Air

Aerial application of endrin granules provides considerable improvement in control of the sugar cane borer pest compared with any other insecticide yet developed, according to U.S. Department of Agriculture and Louisiana Agricultural Experiment Station, which have conducted a cooperative research program on the problem.

Endrin was generally used last sea-

Fluoroflex®-T (Teflon®) HOSE & ASSEMBLIES

engineered for SAFETY, RELIABILITY



HIGH PRESSURE, HIGH TEMPERATURE HOSE for service from −65° to +400°F. Dash 4 through −8 sizes in bulk or to specifications with swaged fittings qualified for 3000 psi systems.

MEDIUM PRESSURE, HIGH TEMPERATURE HOSE for up to 1500 psi service from −100° to +450°F. Dash 3 through −24Z sizes qualified to MIL-H-25579. Available with swaged type or Seal-Lock fittings.

FIREPROOF HOSE, complies with FAA requirements. Construction: Fluoroflex-T tube; AISI Type 304 stainless steel wire braid; specially impregnated asbestos shield, Dash 3 through −24Z with swaged type or Seal-Lock reusable fittings.

PROPELLER FEATHERING HOSE, complies with FAA requirements. Construction: Fluoroflex-T tube; AISI Type 304 braid; two impregnated asbestos shields with intervening air spaces. Available with swaged or Seal-Lock fittings.

®Fluoroflex is a Resistoflex trademark, reg., U.S. pat. off.
®Teflon is DuPont's trademark for TFE fluorocarbon resins.

Originators of high temperature fluorocarbon hose assemblies

Resistoflex CORPORATION DEPT. 278

Offices in principal cities

Roseland, New Jersey • Western Plant: Burbank, Calif. • Southwestern Plant: Dallas, Texas.

SPS RELIABILITY / *A dynamic standard of predictable performance*

5 Ways to Save Fastener Weight

New FN Featherweight locknut series combines minimum mass, outstanding performance

SPS FN-12 Series
Featherweight Hex Locknut

Up to 72% lighter than commonly used sheet metal or AN Series nuts. Tolerance on squareness of bearing surface to threads is 50% less than required by specification, providing reduction in stress concentration. Vibration resistance exceeds MIL-N-25027 requirements by 50%.

Characteristics

Sizes—#4 through ½
Tensile strength—160,000 psi on 180,000 psi tensile bolt
Temperature—550°F max.
Material—Alloy steel
Plating—Cadmium

SPS Bulletin No. 2428

SPS FN-612 Series
Featherweight Hex Locknut

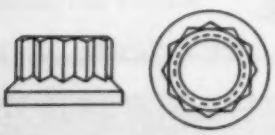
Designed for 800°F service. Corrosion and oxidation resistant; low magnetic permeability. Up to 60% lighter than conventional NAS 679 counterparts. Also less costly because made of austenitic stainless instead of A-286 super alloy.

Characteristics

Sizes—#4 through ⅜
Tensile strength—160,000 psi on 180,000 psi tensile bolt
Temperature—800°F max.
Material—Austenitic stainless
Plating—Silver

SPS Bulletin No. 2521

SPS FN-22 Series Featherweight
12-Point External Wrenching Locknut



Static strength capable of breaking a 220,000 psi tensile bolt. Lightest locknut of this strength available in sizes #10 through 1½. Exceptionally close tolerance on bearing face squareness gives up to 30% longer bolt fatigue life.

Characteristics

Sizes—#10 through 1½
Tensile strength—220,000 psi
Temperature—550°F max.
Material—Alloy steel
Plating—Cadmium

SPS Bulletin No. 2487

SPS FN-920 Series Featherweight
12-Point External Wrenching Locknut

900°F locknut designed for use with high-strength engine bolts having 0.003 in. reduced pitch diameter. Close control of squareness between bearing face and threads makes these the only standard nuts for their temperature meeting squareness requirements of MIL-N-7873.

Characteristics

Sizes—#10 through ⅜
Tensile strength—200,000 psi
Temperature—900°F max.
Material—AMS 6304
Plating—Nickel-cadmium, Silver

SPS Bulletin No. 2504

SPS FN-1218 Series Featherweight
12-Point External Wrenching Locknut

Offers 160,000 psi tensile at room temperature; 140,000 at 1200°F. Reduced stress concentrations achieved by maintaining 0.003 in. bearing face squareness. Simulated service tests document high lock retention during repeated 100 hr. exposure to 1200°F while stressed to 90,000 psi.

Characteristics

Sizes—#10 through ¾
Tensile strength—160,000 psi
Temperature—1200°F max.
Material—SPS-M-118 (A-286)
Plating—Silver

SPS Bulletin No. 2468

Extensive laboratory tests have been conducted on each design of SPS Featherweight series locknuts to insure their meeting or exceeding specification or application requirements. For bulletins or samples, write SPS—manufacturer of precision threaded fasteners and allied products in many metals, including titanium.

AIRCRAFT/MISSILE Division SPS

JENKINTOWN 3, PENNSYLVANIA • SPS WESTERN, SANTA ANA, CAL.

son for the first time in Louisiana to control the borer, considered the most destructive pest of sugar cane. Endrin granules, used in a 2% concentration at the rate of 12 lb./acre, provided approximately 90% control of the borer, at least twice as much protection as ryania granules or dust, and at half the cost, officials state. Ryania has been the best and most extensively used insecticide for controlling this pest, USDA notes.

During 1958, the cost of four aerial applications of endrine granules averaged just under $10/acre. This cost requires that growers obtain yield increases of slightly more than one ton of standard cane per acre to pay for treatments. Average yield increases of almost 7½ tons of cane per acre were obtained in the tests—increases from plots treated with ryania granules or dust average 3½ tons of cane per acre.

Tests comparing effects of endrin and ryania were made by Dr. William H. Long, Dr. L. Dale Newsome and Emile J. Concienne of Louisiana Agricultural Experiment Station and Sess D. Hensley and William J. McCormick of USDA's Agricultural Research Service.

They noticed that four aerial applications of endrin granules at 14-day intervals controlled two generations of the sugar cane borer; four weekly aerial applications of ryania dust of 40% concentration controlled only one generation of the pest.

The scientists recommend that crops be treated with endrin only when at least 2% of the plants are infested by second-generation borers. Treatments generally start between June 10 and June 30 in the southern part of the sugar belt and between June 15 and July 5 in the northern part. Endrin should not be applied within 60 days of harvest, they note.

It is estimated that the borer has annually ruined about 13% of Louisiana's sugar cane for more than 20 yr.; some 14% of this harvest, valued at $6.3 million, was lost in that state in 1958.

Aero Service to Make Surinam Air Survey

A 66,000-sq.-mi. aerial survey to uncover mineral resources in Surinam, Netherlands Guiana, expected to compress in a year's time the work that would take some 10 yr. to do using ground reconnaissance methods, is being done by Aero Service Corp., Philadelphia, and its affiliate, Canadian Aero Service, Ltd., Ottawa.

Cost of the project, covering 80% of Surinam, is estimated as close to $700,000. The target of doing the job in a year is based on getting a good break on weather conditions.

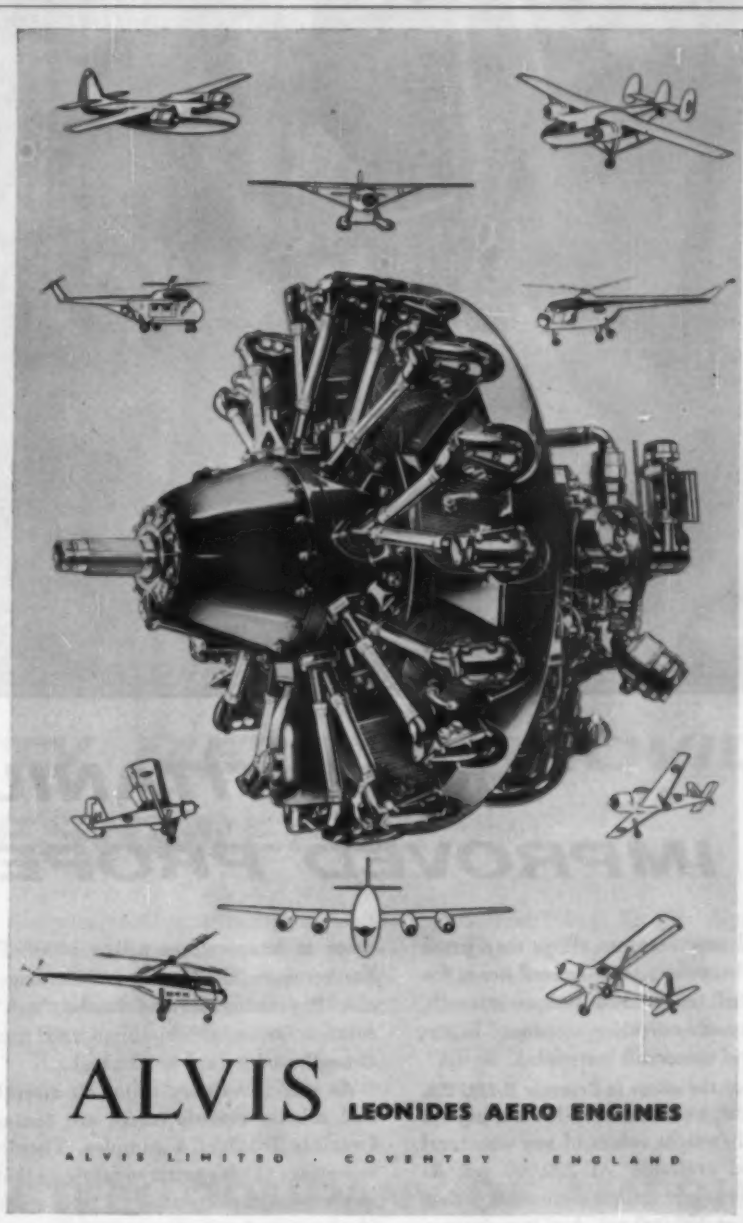
Project, named "Operation Grasshopper," will cover four stages: selection of prime target areas by air surveys, delivery of bulldozers by helicopter to jungle areas to hack out air strips for supply bases, fanning out from these supply bases using helicopters to establish interior sites, and moving ground parties in for detailed studies of likely sites.

Aero Service will utilize General Precision Laboratory Radan navigation system to guide a Douglas DC-3 over a series of grid flight lines spaced about a half-mile apart over the survey area, since there are few landmarks in the dense jungle. Promising areas will be probed from the air at heights of 500 ft. above the jungle using Gulf magnetometer and Mt. Sopris scintillation counter equipment.

A prime target of the search will be iron ore deposits, although other major minerals will also be mapped as they are located.

PRIVATE LINES

Briefing for California private and business pilots on airspace problems and traffic control procedures in restricted areas administered by Pacific Missile Range will be provided July 18 by



a.

NEW TITANIUM ALLOYS, IMPROVED PROPERTIES FOR

Several new titanium alloys may prove to be the answer to designers' needs for improved tensile and fatigue strength, ductility and corrosion resistance in aircraft and spacecraft materials.

One of the alloys is Crucible B-120VCA. This new, weldable alloy has the highest strength/weight values of any structural material available. At 220,000 psi, its strength/weight ratio is equivalent to that of steel at 360,000 psi. And it maintains its strength/weight advantage for short times at temperatures up to 1400° F. Furthermore, B-120VCA is "Formageable"® (readily formed in the "soft" solution annealed condition and then strengthened by age-hardening).

As this is written, about 50 aircraft and missile manufacturers are testing Crucible B-120VCA samples. They're reporting: (1) it's easier to fabricate than any other titanium alloy; (2) it seems ideal for rocket motor cases, structural members, rivets and other components.

Several other critical design problems are being solved by Crucible vacuum-melted steels and superalloys. Some Crucible alloy and tool steels, for example, possess tensile strengths in the 280,000/300,000 psi range and even higher. Up to now, getting uniform transverse ductility at this strength level has been a problem. Crucible solved it through vacuum melting.

These developments are typical of Crucible advances in specialty steelmak-

c.

b.

d.

a. Lowering a consumable electrode into a vacuum arc furnace. Metals produced by vacuum melting are "cleaner" and therefore offer improved strength, ductility and longer fatigue life.

b. Titanium, more than 1000 lbs. of it, saves 800 lbs. in Convair 880 because of metal's high strength/weight ratio. Principal use is in jet engine pods, aileron, stabilizer, and tail assembly.

c. Crucible Vacuum-Melted Bearing Steel makes stronger, longer-lasting bearings. Rejects during manufacture and early failures are virtually eliminated.

d. Vacuum-Melted 4340 was specified for hook pivot pin of bomb rack and rocket launcher when air melted steels failed to withstand 4½ hour destructive vibration tests.

HIGH PURITY METALS PROVIDE MISSILE DESIGNERS

ing. They're possible because Crucible is completely integrated—and because Crucible pioneered in the development of titanium, the high temperature alloys, and in vacuum induction melting and vacuum arc remelting techniques.

Today, Crucible's experience—and newly-increased capacity for vacuum arc remelting of its own special air melted and vacuum induction melted electrodes—provides industry with a complete range of High Purity Metals at lowest cost.

If you'd like to know more about this work, read: "Titanium for Aircraft and Spacecraft" and "Quality Aspects and Engineering Properties of Vacuum Melted Super Alloys and Steels". Write: *Crucible Steel Company of America, Dept. AG-17, The Oliver Bldg., Mellon Square, Pittsburgh 22, Pa.*

CRUCIBLE STEEL COMPANY OF AMERICA

A jet-age classroom for the future men in space ... Cessna's T-37

Pilots of the latest Air Force ultrasonic aircraft are already on the threshold of space. The jet pilots now in training will surely go beyond—and they will have been more quickly prepared for their duties by the newest U.S.A.F. jet trainer—the Cessna T-37.

The T-37 with combat jet characteristics and side-by-side seating simplifies instruction and increases student proficiency. As a result, the Air Force now speeds jet instruction at substantial savings.

Cessna Aircraft Company,
Wichita, Kansas.

Cessna

PMR headquarters at an invitation fly-in at Naval Missile Center, Pt. Mugu. Briefing will include displays of aircraft and missiles used on the PMR.

May sales of $4,096,602, at net factory billing prices, are reported by Piper Aircraft Corp., Lock Haven, Pa., representing a 37% increase in sales over a year ago. Business volume represented a new high for Piper and broke the previous monthly record by more than three quarters of a million dollars. May deliveries included 47 Apache light twins, 105 Comanches, 66 Tri-Pacers and Caribbeans, 59 Super Cubs and PA-18-A agricultural airplanes.

Flight training program especially designed for business use, with courses ranging from private to transport rating, has been inaugurated by Remmert-Werner, Inc., Lambert Field, St. Louis, using aircraft from Cessna 172 to Douglas DC-3 types. Program will also be expanded to firm's Toledo, Trenton and Pompano Beach operations. Company operated flight school until 1949, is re-entering the field because it feels business fleet growth provides excellent market for such training operations.

Esso Turbine Fuel 1-A is being stocked for business aircraft at Teterboro (N. J.) Airport. Atlantic Aviation Corp. reports that it is carrying 3,000 gal. of the fuel currently. A 20,000-gal. storage area was completed recently at the field.

Johns-Manville took delivery of a Fairchild F-27 turboprop executive transport to link its 33 plants and three mine locations in the U. S. and Canada. Johns-Manville, which also has a Douglas DC-3, reports that its business aircraft department has flown more than 5,000 passengers more than eight million passenger miles without mishap since its inception in 1946. Base for its planes is Westchester (N. Y.) County Airport.

Lightweight B. F. Goodrich pneumatic de-icing system is available as a factory installation on Cessna 310C light twin business plane for an installed cost of $2,950; or installed in the field using a kit. New gear costs $2,300 less than previous equipment. Cessna reports; weighs 50.3 lb. installed compared with 93.5 lb. for earlier gear.

California is far out in first place in number of registered and active pilots in U. S. as of Jan. 1, 1959, with a total of 102,709--47,068 of these being active; Texas second with 25,614 active pilots of a total of 58,517 registered. Active pilots in U. S., including Hawaii, total 352,469 out of a total registration of 832,766.

why
Edgewater
rolled steel rings
are best . . .
A solid steel block is heated to forging temperature, and thoroughly soaked.
The block is upset on a forging press, and the center is punched out.
On the rolling mill, the heated punched block revolves between main and pressure rolls, where its diameter grows and section shape is formed. Edging rolls control width.
Below—representative sections of rings rolled by Edgewater.

From a solid block of steel, a solid ring has been formed, to required size and shape. The accuracy possible with this process greatly minimizes the need for further finishing. Diameters are from 5 to 145 inches, weights up to 14,000 pounds. Materials include carbon and alloy steels, stainless, tool steels, titanium. Facilities available for machining and heat treatment.

Write for descriptive bulletin.

Edgewater Steel Company

Dept. AW • P.O. Box 478 • Pittsburgh 30, Pa.

ESSO

WING TIPS

DON'T BE DECEIVED. Being surrounded by mountains produces illusions which could be dangerous. One is using a distant mountain for a horizon. The danger is that you're likely to keep pulling up the nose till you stall. Be safe – check air speed and altimeter regularly in this situation.

BE A "MUDWATCHER". Sudden downpours are likely to create hazardous taxiing situations for the pilot. Innocent-looking puddles may cover a virtual quagmire which will nose over many a light plane or even a twin engine ship. So when taxiing – be wary – be wary – beware – of mud!

BEWARE OF "T" CLOUDS. Big Chief Thunderhead will have your scalp if you unwittingly cross his path. Violent updrafts and downdrafts, skin-tearing hailstones and the usual lightning and rain may be your downfall if you decide to risk it. Even the overhang is treacherous, never fly near it. Either go around or beat a safe path home.

DEALER SERVICE. From Maine to Louisiana – you'll find many Esso Dealer Airports conveniently located to provide high quality Esso products – the first preference of experienced pilots. Esso Aviation Credit Cards, Esso Flight Plan Sequence Cards and Flight Calculators are some of the many service aids which Esso Aviation Dealers provide to pilots.

ESSO STANDARD OIL COMPANY

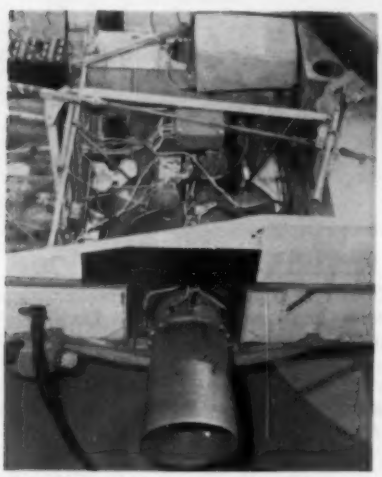
Highways or Skyways..."ESSO RESEARCH works wonders with oil"

PIASECKI demonstrated steady hover capability of VZ-8P at altitudes from a few feet off the ground to about 20 ft. Army thus far has funded approximately $1,444,960 on VZ-8P.

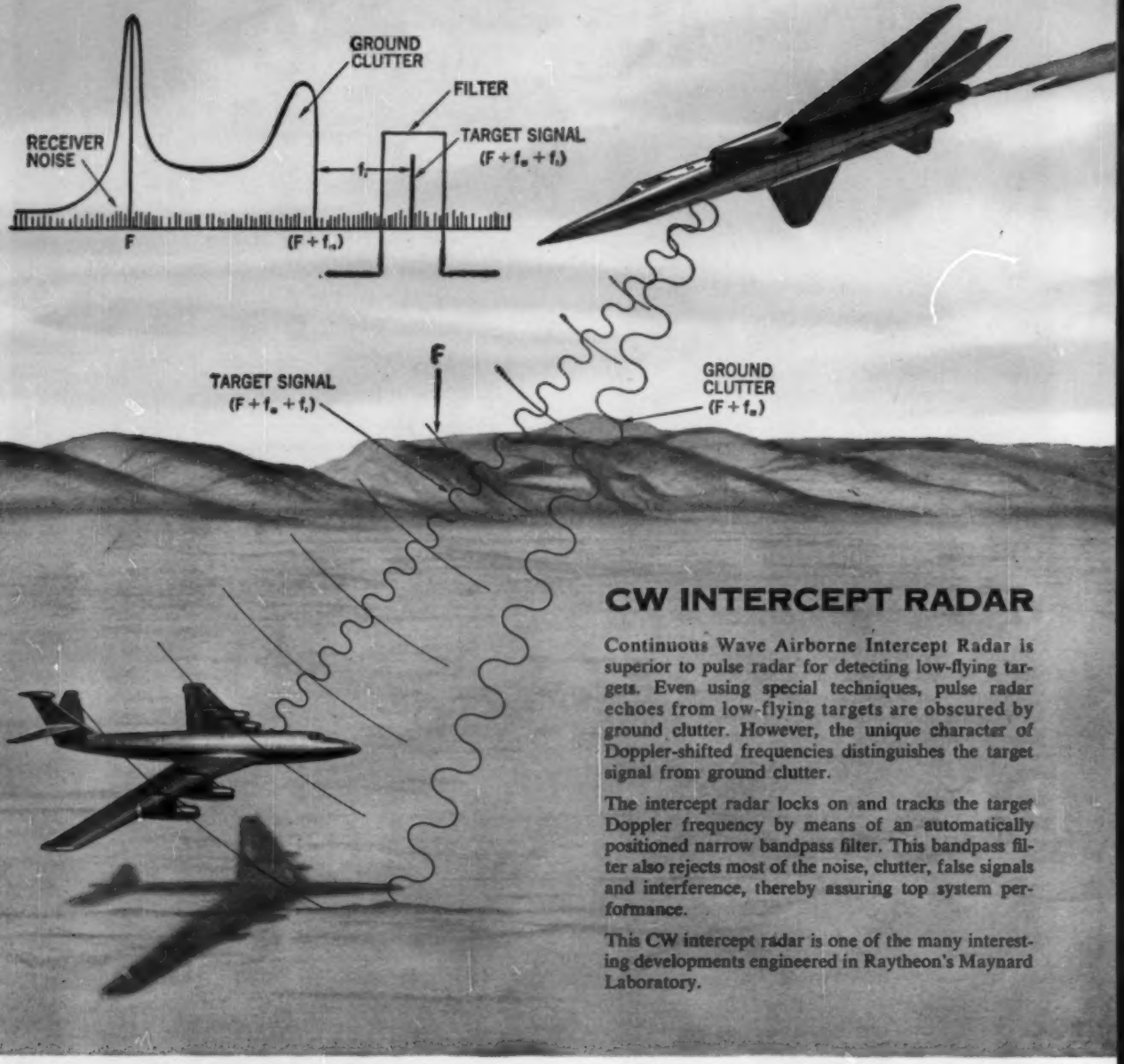
Turbine Improves VZ-8P Performance

Marked improvement in handling characteristics of VZ-8P U. S. Army flying platform testbed, provided by installation of 425-shp. Turbomeca Artouste IIB turbine replacing previous pair of 180-hp. Lycoming piston engines, was demonstrated recently by Frank Piasecki at Philadelphia (Pa.) International Airport. Improved maneuvering and hovering capabilities were apparent as Piasecki handled the VZ-8P over both paved and grass areas of airport.

NOSE-DOWN attitude during high-speed run is assumed to show controllability at low level. Shadow pattern (below) delineates system of control vanes located under ducts.



TURBOMECA turbine is installed on port side next to pilot. Number 2 VZ-8P, proposed by Piasecki, would have two turbines.



CW INTERCEPT RADAR

Continuous Wave Airborne Intercept Radar is superior to pulse radar for detecting low-flying targets. Even using special techniques, pulse radar echoes from low-flying targets are obscured by ground clutter. However, the unique character of Doppler-shifted frequencies distinguishes the target signal from ground clutter.

The intercept radar locks on and tracks the target Doppler frequency by means of an automatically positioned narrow bandpass filter. This bandpass filter also rejects most of the noise, clutter, false signals and interference, thereby assuring top system performance.

This CW intercept radar is one of the many interesting developments engineered in Raytheon's Maynard Laboratory.

PROFESSIONAL ASSOCIATION WITH A FUTURE

Raytheon has excellent openings for qualified engineers and physical scientists with BS or advanced degrees. Positions are available in systems, development, design or manufacturing engineering of complex electronic equipments. Please write Donald H. Sweet, Government Equipment Division, Raytheon Company, 624 Worcester Rd., Framingham, Mass.

Engineering Laboratories: *Wayland, Maynard, Sudbury, Mass.; Santa Barbara, Calif.*
Manufacturing Facilities: *North Dighton, Waltham, Mass.*

RAYTHEON

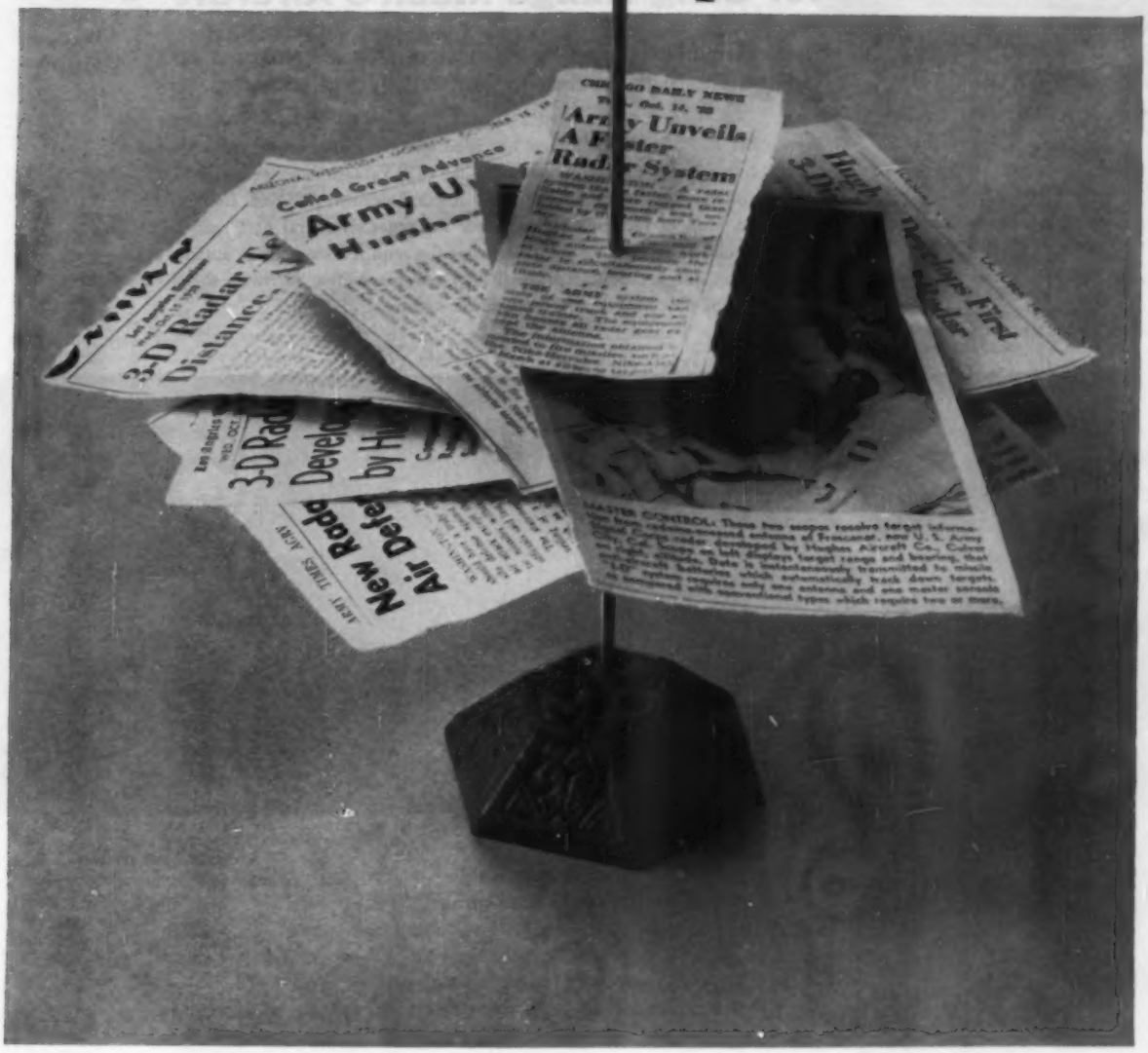
Excellence in Electronics

GOVERNMENT EQUIPMENT DIVISION

LAND SEA AEROSPACE

WANTED:

Engineers who can top these stories



Hughes new frequency scanning radar has been called the most important new development in the art since radar itself was conceived. Mechanical antenna movement has been largely eliminated. The radar beam is positioned in space by varying the frequency of the electromagnetic energy applied to the antenna.

Already, this new principle has proved its mettle. The Army's new Frescanar radar handles a large number of targets with great accuracy and presents all information with three-dimensional realism.

Obviously this is but one step in the evolution of this new radar principle. Hughes Fullerton needs engineers who can exploit this breakthrough and go on to discover new commercial and military applications as yet undreamed of.

Hughes Fullerton is now rapidly expanding. While the main emphasis is on advanced Research and development work, there are positions open in a variety of engineering activities.

If you are the engineer interested in truly stimulating work, with an eye for solid opportunity and personal and professional growth, we invite your inquiry. Please contact Mr. L. V. Wike.

the West's leader in electronics

HUGHES

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GROUND SYSTEMS
Personnel Selection & Placement
Hughes Aircraft Company
Fullerton 9, Orange County, California

ARMCO STEELS / for Aircraft and Missiles

Armco PH 15-7 Mo Stainless Steel Provides Structural Efficiency for Long-Range Mach 3 Aircraft

New precipitation-hardening stainless combines strength at 2000 mph temperatures with producibility, availability and economy.

Armco PH 15-7 Mo Stainless Steel has been selected as the primary sheet metal for the dramatic new air weapon systems—the B-70 Valkyrie bomber and the F-108 Rapier manned interceptor—being developed by North American Aviation, Inc. for the Air Force. Most of the honeycomb panels and other structural parts will be made of this special stainless because it possesses the required strength at anticipated temperatures and a unique combination of advantages that facilitate the design and production of dependable and economical structural elements.

Armco PH 15-7 Mo Stainless Steel—

- Has high strength-weight ratios up to 1000 F.
- Resists deformation at flight stresses and temperatures.
- Is available in practically all commercial forms—foil, sheets, strip, plates, bars, wire, and forging billets.
- Resists corrosion, eliminates the weight penalty of corrosion protective coatings.
- Can be welded and brazed. Brazing is compatible with heat treatment.
- Is formed in soft condition, then hardened by simple heat treatment.

For the airframes, power plants or accessories of supersonic air vehicles, consider the opportunities to economically improve performance and reliability by specifying Armco PH 15-7 Mo Stainless. Write Armco Steel Corporation, 2829 Curtis Street, Middletown, Ohio, for design data and fabricating information.

ARMCO STEEL

Armco Division • Sheffield Division • The National Supply Company • Armco Drainage & Metal Products, Inc. • The Armco International Corporation • Union Wire Rope Corporation • Southwest Steel Products

WHO'S WHERE

(Continued from page 23)

Changes

Melvin A. Brenner, an assistant vice president, American Airlines, Inc. Mr. Brenner continues as director of schedule planning and forecasting.

Harlan S. Hosler, manager, Kaman Aircraft Corp.'s Washington, D. C., office.

Harry M. Stephey, manager of defense requirements, Missile and Space Vehicle Department of the General Electric Co., Philadelphia, Pa. Also: **Glen P. Bieging,** manager of marketing.

Franklyn E. Dailey, Jr., manager of planning, Stromberg-Carlson, a division of General Dynamics Corp., San Diego, Calif. Also: **Walter E. Sargent,** supervisor of production engineering; **Robert R. Pierce,** purchasing agent.

Robert Tate, director-avionic sales and service division, General Precision Laboratory, Inc., Pleasantville, N. Y., a subsidiary of General Precision Equipment Corp.

Dr. Roman K. C. Johns, principal scientist for geophysics and astronomy, Baird-Atomic, Inc., Cambridge, Mass.

D. M. Heller, staff assistant for special engineering assignments to the vice president and group executive of Bendix Aviation Corp., South Bend, Ind.

Jerome S. Goldhammer, manager-reconnaissance systems and planning, Chicago Aerial Industries, Inc., Melrose Park, Ill. Also: **Charles Hybarger,** marketing manager.

Bruce K. Smith, assistant to the president for advanced product technology, Epsco, Inc., Cambridge, Mass. Also: **Rear Adm. Roy H. Callahan** (USN, ret.), director of operations.

Charles R. Wilson, production manager, West Coast Division of the Military Electronic Operations of Allen B. DuMont Laboratories, Inc., Los Angeles, Calif.

Dr. Robert M. Witucki and **Dr. David M. Heinz,** senior scientists, Hoffman Electronics Corp.'s Science Center, Santa Barbara, Calif.

Paul F. Pearce, manager of project engineering, and **Gunnar Wennerberg,** head of product development, Lockheed Electronics and Avionics Division, Los Angeles, Calif.

Robert C. Kolts, marketing manager, Airtron, Inc., Linden, N. J., a division of Litton Industries. Also: **Robert M. Hautzik,** chief engineer of Airtron's West Coast facility, Los Angeles, Calif.

R. S. Anderson, operations manager, Special Products Division, Leach Corp., Compton, Calif.

Dr. Robert E. Samuelson, assistant general manager for research and development, Motorola's Western Military Electronics Center, Phoenix, Ariz.

Marquardt Corp.'s Power Systems Group, Van Nuys, Calif., has established two new divisions and made the following appointments: **Paul J. Papanek,** director, Marketing Division, and **Richard A. Davis,** director, Administration Division. Also: **L. E. Dunn,** director of the Power Systems Group's Test Division.

Martin Fleer, public relations director, National Aeronautic Assn., Washington, D. C.

Lilbern A. Lawson, chief engineer, Osborne Electronic Corp., Portland, Ore.

Jack R. Walchli, manager, Licensing and Research Department of Navan Products, Inc., subsidiary of North American Aviation, El Segundo, Calif.

Lt. Robert James Kennedy (USNR), VZ-8P test pilot, Piasecki Aircraft Corp., Philadelphia, Pa.

Robert Beagles, chief engineer of advanced development, Technical Products Division, Packard Bell Electronics Corp., Los Angeles, Calif. Also: **Hal V. Miller,** liaison engineer at Redbank, N. J., for the Technical Products Division.

James O. Seamans, Sparrow III program manager, Missile Systems Division of Raytheon Co., Waltham, Mass.

Dr. Raymond M. Wilmotte has joined the staff of Advanced Military Systems, Defense Electronic Products, Radio Corp. of America, Princeton, N. J.

William E. Doherty, Jr., sales manager of commercial aircraft sales, Schweizer Aircraft Corp., Elmira, N. Y.

Ray P. Lambeck, engineering manager-major programs, Aero Hydraulics Division, Vickers, Inc., division of Sperry Rand Corp., Detroit, Mich.

Orlando R. Follett, systems engineer, and **Arden F. Boyd,** engineering specialist-dynamic analysis of flight control systems, Summers Gyroscope Co., Santa Monica, Calif.

Gerrett B. Conover, assistant chief engineer, Propulsion Test Facilities, Inc., an affiliate of MB Electronics, a division of Textron Electronics, Inc., New Haven, Conn.

FLEXITE® TEFLON® TUBING

For mechanical or electrical use, Markel FLEXITE Teflon tubing rates superior in resistance to corrosives, solvents, oils, moisture and abrasion—yet it stays flexible and has excellent electrical properties at temperatures from −130°F to 480°F.

Markel, the leader in the field since 1923, also makes precision FLEXITE in a variety of other plastics—in sizes from #30 to 2½"—for every tubing application. Name your requirements—for samples and prices.

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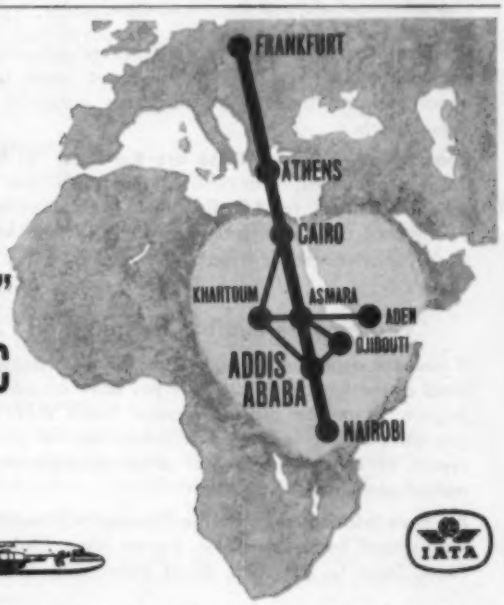
INSULATING TUBINGS AND LEAD WIRE

NORRISTOWN, PENNSYLVANIA

FLY THE GATEWAY ROUTE TO THE "HEART" OF HISTORIC AFRICA



Fly the route of history via Ethiopian Airlines! See Cairo . . . the Red Sea . . . and Ethiopia, Land of the Queen of Sheba. Africa offers today's *greatest business potential, newest travel adventure.* Fly overnight in luxurious DC-6B's from Frankfurt (now 4 flights weekly) to Greece, Egypt, Sudan, Ethiopia and Kenya. Incomparable service.

Visit one of our 5,000 offices in the United States and Europe—YOUR TRAVEL AGENT.

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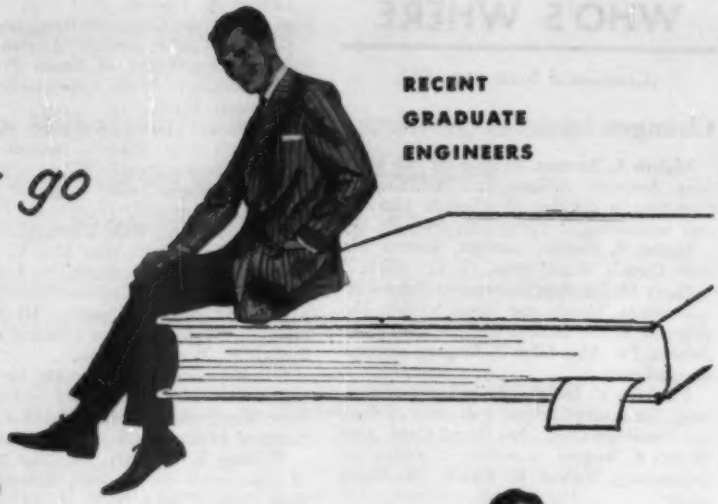
ETHIOPIAN AIRLINES

THE WONDERLAND ROUTE

How far can an engineer go at AC?



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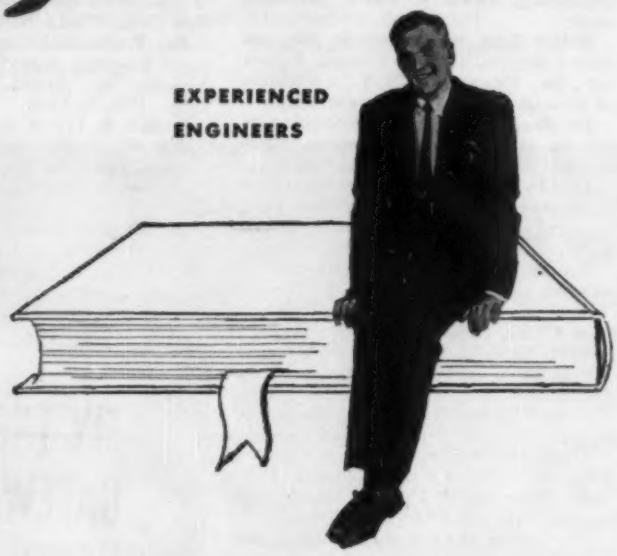

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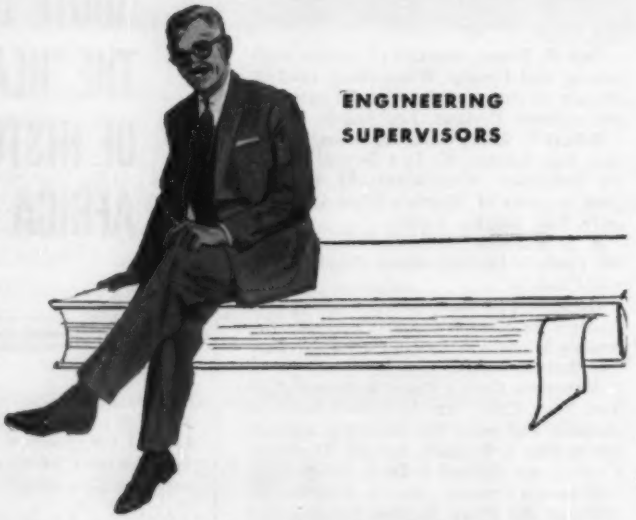

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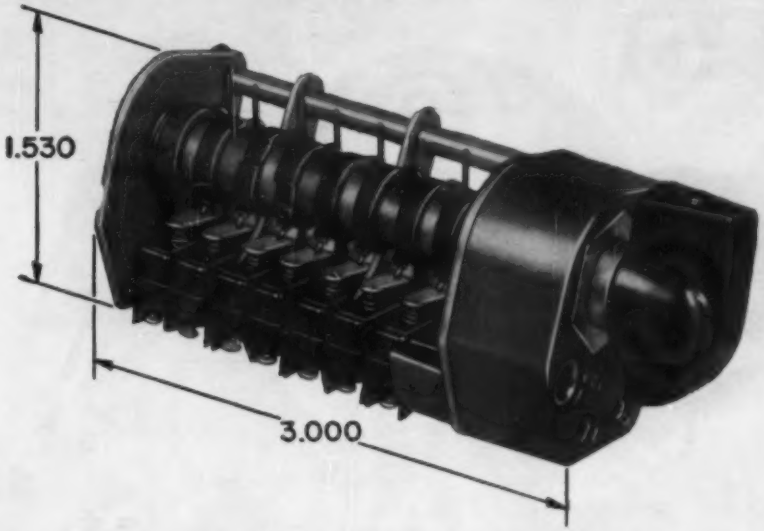
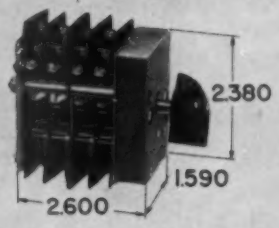
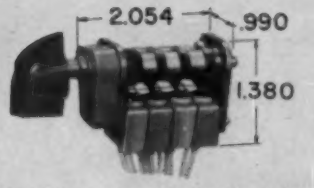


New rotary selector switch assemblies feature "cock-and-fire" actuation

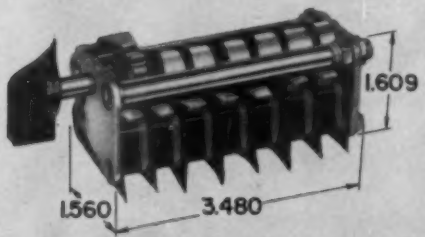
OTHER ROTARY ASSEMBLIES



"20AS" series double-row "V3" assembly (Knob not furnished)



"25AS" series sealed subminiature assembly (Knob not furnished)



"7AS" series single-row "V3" assembly (Knob not furnished)

The new "28AS" Series of rotary selector switch assemblies have a "cock-and-fire" actuating mechanism that moves positively from one position to another, imparts a good feel of the detent action and provides immediate indication of each position. Aircraft engineers have found these switches ideal for mounting in close-coupled designs. Features include:

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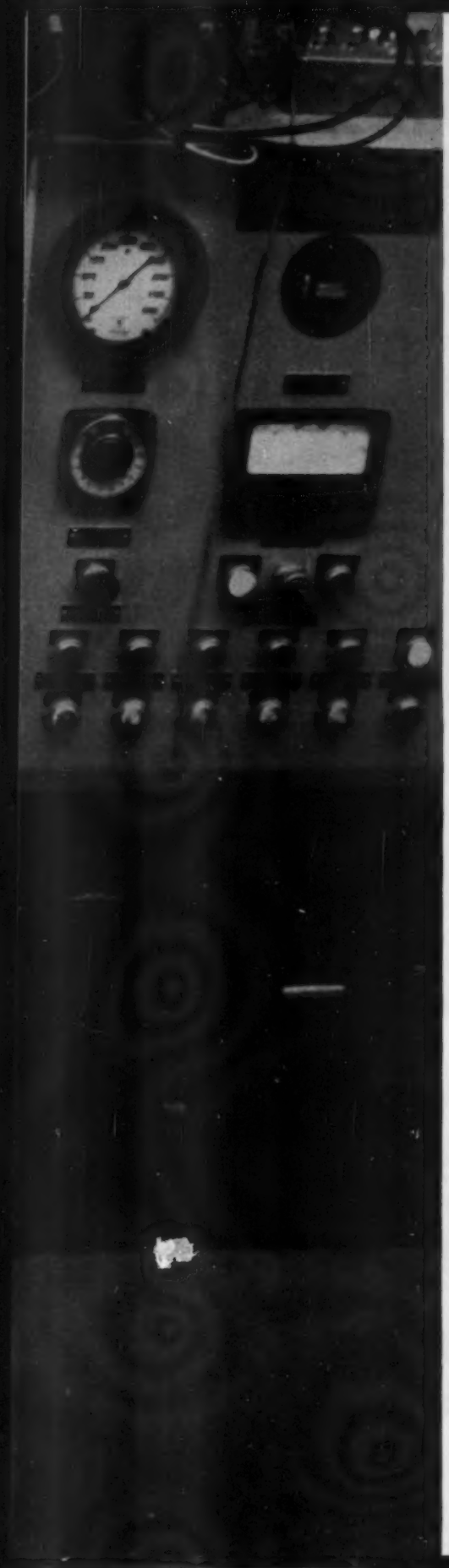

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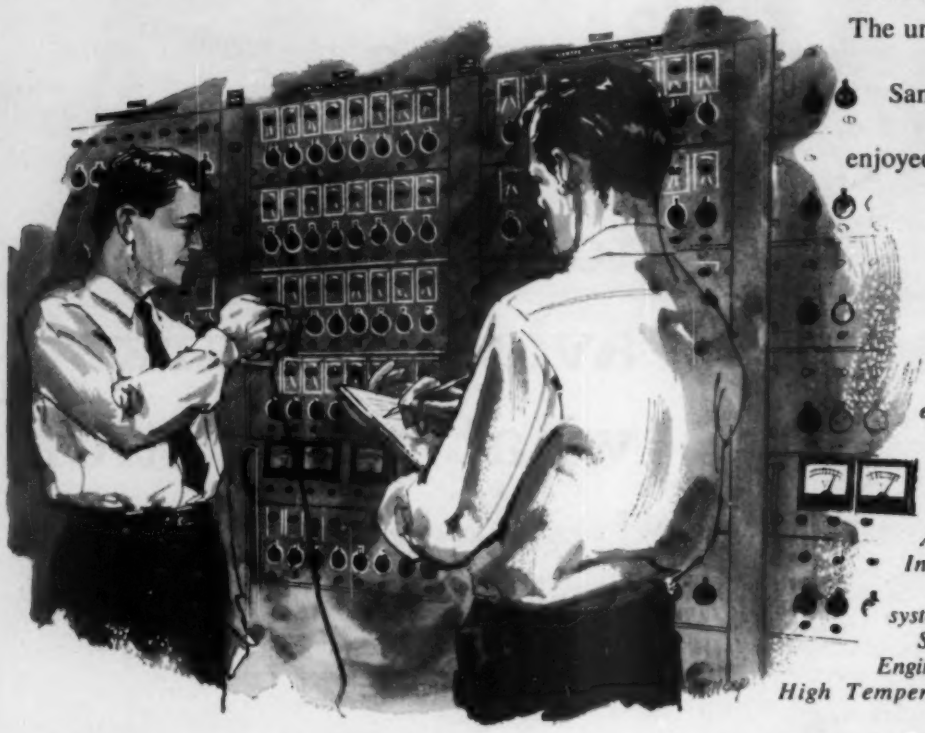

Illustration shows engineers balancing a transducer bridge with a servo gun on signal conditioner rack of DAISY (Data Acquisition and Interpretation System), a 400 channel data system, designed by Convair San Diego Electronic Engineers for use in Convair High Temperature Structures Test Laboratory.

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David Green

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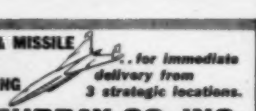

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How to use: Check the dealer ads to see if what you want is not currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to

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c/o Aviation Week
Classified Advertising Division
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Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

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TEST EQUIPMENT ENGINEERS

If you've been looking for an opportunity to explore new engineering territory, the positions now open in our electronics test equipment group may be right down your alley.

We need engineers to do research and development based on an entirely new electronics test equipment philosophy. Briefly, the job involves design of test equipment and analysis of electronics designs submitted by vendors and subcontractors. This is one phase of our work on advanced weapon systems B-70 and F-108.

A BSEE, plus experience, can qualify you.

For more information please write to: Mr. A. G. Stevenson, Engineering Personnel, North American Aviation, Inc., Los Angeles 15, Calif.

THE LOS ANGELES DIVISION OF
NORTH AMERICAN AVIATION, INC.

LETTERS

Avionics Chart

Your June 1 report on the National Conference on Aeronautical Electronics ("Systems Integration Is USAF Hurdle," p. 99) is another example of your usually fine reporting ability. However, the illustration which proceeds it based on William Morrow's work at Lincoln Laboratories is misleading unless considerable explanation accompanies it.

The range and capacity given for meteor trail, ground waves, ionosphere scatter and ionospheric reflection are valid in terms of the specific assumptions that were used in making the evaluation. Let me illustrate this by selecting a new set of assumptions and examining one of these. If I assume that I can parallel as many transmitting tubes as I choose each of which is matched into a tall low-frequency transmitting antenna tower I can easily demonstrate a 3,000 mi. range with 10,000 bits per second.

Since the only range limitation for any specified bandwith is the effective gain of the antenna and the transmitted power, a 10 tower broadside array with each tower fed by a commonly phased transmitter would produce adequate signals at 3,000 mi. This range capability at 100 kc. for example has already been demonstrated and reported in the literature. Bandwith increases while limited to a finite portion of the carrier frequency is reflected only in terms of power increase. The same kind of arguments can be used with ionospheric scatter to show that the bandwith can be increased or with meteor trail to increase its capacity.

The reported capacity versus range decrease shown for tropospheric systems can also be readily modified by making new assumptions. The obvious one, of course, is the use of increased power. Some systems of over 500 mi. have been demonstrated for narrower bandwidth than 107. This limitation can be readily overcome with increased power from the transmitters and larger antennas.

The matter of reliability also requires considerable explanation of the assumptions used before the comparative analysis chart has any validity. Let me illustrate this in terms of the submarine cable. If we define reliability in terms of the natural limitations on the availability of circuitry, then it is true that a submarine cable when properly installed has the indicated reliability. On the other hand if we allow man-made interference, then its reliability will drop markedly.

Witness the cutting of several cables across the Atlantic recently or the cutting of the cables across the Pacific by the Japanese in World War II.

The same kind of arguments can be used in active and passive satellities. If you admit jamming as a factor in measurement of reliability, an active satellite does not permit continuous anti-jam improvement once it has been launched. On the other hand the passive satellite containing no electronics permits continuous counter-countermeasures on the part of the ground stations where they are accessible to the human beings who are doing the communicating.

Insofar as the cost per bit mile. I have my own methods of evaluating the various transmision media and Morrow's results do not necessarily agree with my findings; however, since our assumptions are different, there is really no basis for comparison.

Dr. Joseph H. Vogelman
Technical Director
Communications
Rome Air Development Center
Griffiss Air Force Base, N.Y.

(Dr. Vogelman's letter was forwarded to Mr. Morrow; following is Mr. Morrow's reply—Ed.)

The values given for the various systems in the chart are for contemporary communications systems as they operate today and do not take into account the improvement discussed by Dr. Vogelman. In the case of the satellite systems the parameters represent those which can be achieved with equipment that is available today or within the next few years. It is certainly true that if one concentrates on any one of these systems, it is possible to increase the capacity, the range, and possibly the reliability, although these improvements are likely to be very expensive.

The chart does not take into acount adverse acts by an enemy, such as jamming or cutting of submarine cables. This aspect was not included because of the unclassified nature of the NAECON Conference. It should be further pointed out that the values given are good only to an order of magnitude because even minor changes in the assumptions about the equipment used will make considerable changes in the system capabilities.

Nevertheless, I feel that this chart is quite instructive because it shows that there is a very wide spread in the capabilities of the various techniques which in some cases amounts to six orders of magnitude.

W. E. Morrow
Massachusetts Institute of Technology
Lincoln Laboratory
Lexington, Mass.

Aviation Week welcomes the opinions of its readers on the issues raised in the magazine's editorial columns. Address letters to the Editor, Aviation Week, 330 W. 42nd St., New York 36, N. Y. Try to keep letters under 500 words and give a genuine identification. We will not print anonymous letters, but names of writers will be withheld on request.

Not Canceling

I am a subscriber of Aviation Week for many years. In my opinion, it is one of the finest aviation informative magazines in the world. At times you may not print all of the correct information, however, the general outline appears to be always correct. It is my belief that people shout loudest when the truth hurts.

In conclusion, do not cancel my subscription.

Henry Zacek
Farmingdale, N. Y.

IFR-VFR Dilemma

It is time to take to task the ever increasing number of so-called public servants who claim that the days of "see and be seen" are gone. They are not gone, and they will not be gone as long as long as general aviation has one piece of intestine left.

The Curtis report has provided for implementation of this segment of aviation, and either it will be provided or there will be considerable diffioulty to be expected in the future trying to enforce anything more stringent. The air over this country has been free, is free, and will remain free, else considerable excitement may be expected. Let us, from this point forth, cease publishing unenforceable, wild statements of the type made by Gen. Caldara. Civilian aviation will continue to move forward in a manner to best serve the majority needs and desires, so let's just go right ahead and design our traffic control procedures to promote maximum safety with compatible IFR and VFR instead of always inferring that the sledge hammer is about to fall on the largest segment of American aviation.

D. M. Nichols, Manager
Meadow-Aire Airport
LaGrange, Ohio

Early Birds

Recently the few remaining Early Birds sponsored a European trip to commemorate the 50th anniversary of Louis Bleriot's flight across the English Channel. This project involved air transportation across the United States to Paris, France. The entourage was to leave Idlewild June 12 and return June 26.

It is indeed unfortunate that many of the remaining Early Birds were deprived of being present due to financial considerations and thus saluting the great pioneer, Louis Bleriot, by being present. The lot of many of the early air pioneers has not been an easy one with the rising cost of living. The few that remain, in most instances, have limited resources.

One of the earliest of pioneers recently died of what the newspapers reported as malnutrition.

It would seem to be in order if the large and vested aviation interests in the United States could have contributed to the transportation fund to permit as many of the Early Birds to attend this tribute to Louis Bleriot as possible. In these days of airplane and airline contracts that amount to millions of dollars, a few dollars set aside from the profits could be devoted to making the remaining days of those Early Birds in need of assistance less difficult.

We owe a great debt to those early air pioneers who risked their lives and dollars to create a billion dollar industry that in the rush to conquer space has forgotten that without the daring and fortitude of our early airmen there may not have been created the vast air industry we have today.

Harry P. Christofferson
Member, Early Birds
San Francisco, Calif.

advanced

PRECISION COMPUTING RESOLVERS

for

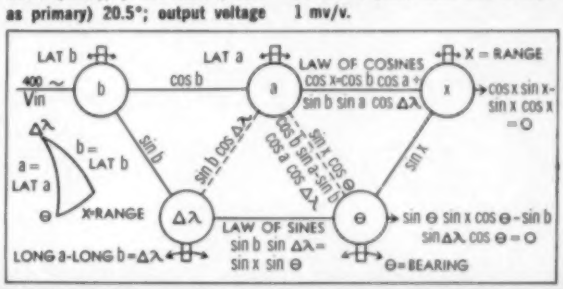
Cascaded Resolver Systems

SIZE 8 FEEDBACK WINDING RESOLVERS

These resolvers are designed for use with transistorized amplifiers and permit the solution of spherical triangles in a size 8 cascaded resolver chain.

Functions of the spherical triangle which can be produced are indicated in the schematic below. More complex trigonometric functions, as well as systems involving coordinate axis transformation, can be generated with the use of these resolvers.

Accuracy: Functional error .1% or less; winding perp. ±5′. Electrical characteristics: Input voltage 15v400~ (stator); output voltage 13.7v (rotor); phase shift (stator as primary) 20.5°; output voltage 13.7v (compensator); Zro 234 + j596; Zso 244 + j548; Zcompensator 237 + j553; max. null voltage 1 mv/v.

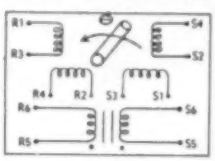


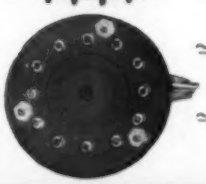
SIZE 11 AMPLIFIERLESS RESOLVER FOR ANGULAR DATA TRANSMISSION

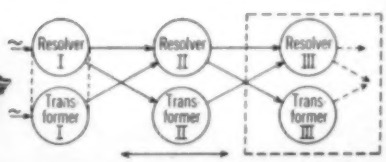
These size 11 resolvers incorporate an integral transformer which simulates a resolver function at maximum coupling. They are used in the typical chain application indicated below for angular data transmission. In this particular application, the output information can be servoed at either end of the chain.

Quick disconnect allows ease in harnessing.

Accuracy: ±5′ of arc or less; winding perp. ±5′. Electrical characteristics: Input to EITHER rotor or stator. Input voltage 115v1600~; output voltage 110v both stator and rotor as primary; phase shift (stator primary) 1.1°; phase shift (rotor primary) 1.9°; Zso (nom.) 990 + j13500; Zro (nom.) 1150 + j13500.







SIZE 11 RESOLVER TRIMMED FOR ZERO PHASE SHIFT CONTAINS ALL COMPENSATION IN 2¼" LENGTH

The YZC-11-E-1 precision computing resolver has been developed for use in a cascaded, amplifierless resolver system at 900~.

These units have been trimmed to provide zero phase shift and compensated for transformation ratio stability, under temperature, when working into their iterative impedance.

Accuracy: Functional error .1% or less; winding perp. ±5′. Electrical characteristics: Input voltage (stator) 40v900~; output voltage (rotor) 33.2v; phase shift 0; max. null voltage 1 mv/v.

Also ready for delivery is an equivalent, compatible pancake resolver. By its use, differential information from an inertial platform may be obtained and introduced into the system.

ENGINEERS—Join the leader in the rotating components field. Write David D. Brown, Director of Personnel, Dept. J7

cppc CLIFTON PRECISION PRODUCTS Co., Inc.

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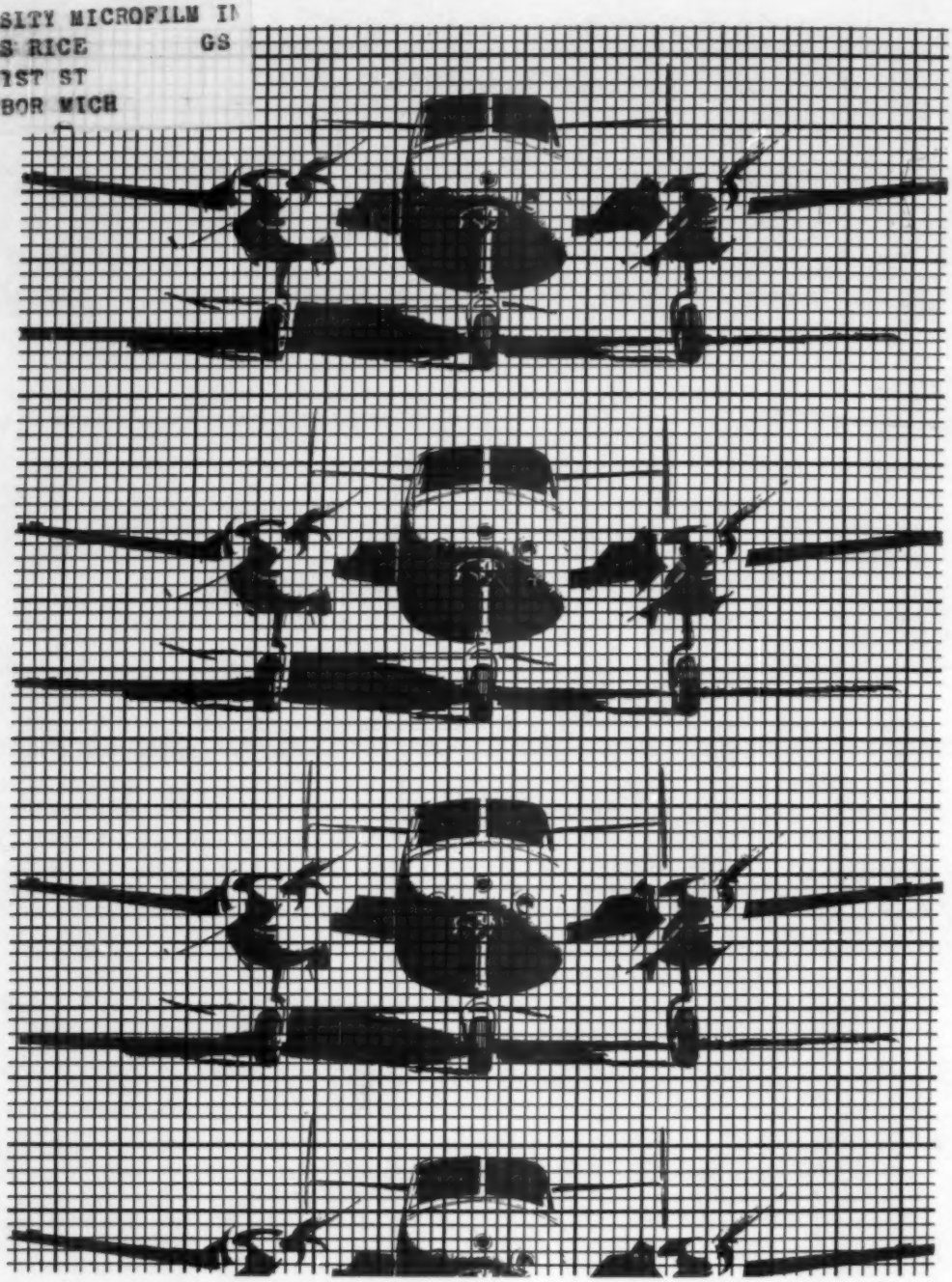

Lycoming's forecast for business aviation: Ceiling Unlimited—More and more executives are finding that "taking the company plane" saves time, saves money. As a result, the business aviation industry has doubled its output in just two years. For rugged and dependable engines for their planes, these aircraft manufacturers look to Avco's Lycoming Division . . . now powering 3 out of every 4 twin-engined executive aircraft made in the United States.

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